EFFECTS OF STIMULUS SPEED, EXERCISE INTENSITY, AND EXPERIENCE LEVEL ON COINCIDENCE ANTICIPATION TIMING IN BADMINTON PLAYERS

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ABSTRACT

EFFECTS OF STIMULUS SPEED, EXERCISE INTENSITY, AND EXPERIENCE LEVEL ON COINCIDENCE ANTICIPATION TIMING IN BADMINTON PLAYERS

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The purpose of this study was to examine the effects of stimulus speed, exercise intensity, and experience level (experienced, novice, & sedentary) on coincidence-anticipation timing performance of adolescent badminton players. 139 participants consist of experienced (n=42), novice (n=43) badminton players, and sedentary (n=54) with the age range of 11 to 17 years old voluntarily participated in the presented study after ethical approval. Coincidence anticipation timing scores was evaluated by Bassin Anticipation Timer apparatus at 1 mph (low), 3 mph (middle) and 5 mph (high) stimulus speeds using an incremental running protocol under different exercise intensities a) Rest, b) 70%, and c) 90% Heart Rate Reserve on a treadmill. The results (Raw scores) were converted into two types of errors (Absolute & Variable Errors), representing accuracy and variability, correspondingly. Mixed model ANOVAs demonstrated that badminton players performed significantly better than sedentary participants for both absolute and variable errors, also experienced players performed better than beginner badminton players

and sedentary participants. The results also showed that there were significant differences among stimulus speeds of both groups in 70 % exercise intensity. Additionally, there was no significant difference between experienced and novice players in 90% exercise intensity. The findings of this study concluded that novice players and sedentary participants had some difficulties anticipating high stimulus speed in rest conditions and high exercise intensity compared to experienced badminton players. So, the outcomes of the presented study offer that badminton trainers should make training sessions of novice players working with each other at high speeds.

Keywords: sport participation, coincidence anticipation timing, sedentary, exercise intensity, stimulus speed

ÖZ

FARKLI UYARI HIZI, EGZERSİZ ŞİDDETİ VE DENEYİM DÜZEYİNİN BADMİNTONCULARDAKİ SEZİNLEME ZAMANI PERFORMANSI ÜZERİNE ETKİSİ

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Bu çalışmanın amacı, genç badminton oyuncularında farklı egzersiz şiddeti ve uyarı hızının "Zamansal Sezinleme Süresi" (ZSS) performansı üzerindeki etkisini, spor deneyimi (deneyimli, acemi ve sedanter) göre incelemektir. Bunun için yaşları 11 ve 17 arasında olan 139 gönüllü katılımcı; deneyimli (n=42), acemi (n=43) badminton oyuncusu ve sedanter (n=54) etik kurulu onayından sonra bu çalışmaya katılmışlardır. ZSS performansı şiddeti artan bir koşu protokolü aracılığıyla üç farklı egzersiz şiddeti (dinlenik, %70 ve %90 Kalp Atışı Rezervinde) ve üç farklı uyarı hızında 1 mph (düşük), 3 mph (orta) ve 5 mph (yüksek) Bassin Sezinleme Zamanlayıcısı kullanılarak ölçülmüştür. Veriler "Mutlak Sabit Hata" ve "Değişken Hata" olarak doğruluk ve tutarlık göstergesi olarak kullanılmıştır. Tekrarlanan ölçümlerde varyans analizi sonuçları, erkeklerin üç egzersiz şiddeti durumunda ve düşük (1 mph) uyarı hızında, kızlara göre daha doğru ZSS performanslarının olduğunu göstermiştir. Karma model ANOVA sonuçlarına dayanarak, badminton oyuncularının hem mutlak hem değişken hatalar için sedanter katılımcılardan daha

anlamlı fark bulunmuştur, Ayrıca deneyimli oyuncular acemi oyunculardan ve sedanter katılımcılardan daha doğru ve tutarlı performans göstermiştir. Bunlara ek olarak orta şiddetli egzersizde (%70) ve her üç uyarı hızında deneyimli oyuncuların daha doğru ve tutarlı olduklarını görülmüştür. Son olarak yüksek şiddetli (%90) egzersiz durumunda analiz sonuçlarına dayanarak anlamlı bir fark saptanmamıştır.

Anahtar Kelimeler: spor katılımı, sezinleme zamanını, sedanter, egzersiz şiddeti, uyarı hızı

To Source of Joy

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LIST OF ABBREVIATIONS

CAT	Coincidence Anticipation Timing
CTA	Coincidence Timing Accuracy
BAT	Bassin Anticipation Timer
HRR	Heart Rate Reserve
HRRest	Resting Heart Rate
HRmax	Maximum Heart Rate
HRpeak	Peak Heart Rate
|CE|	Absolute Constant Error
VE	Variable Error

CHAPTER 1

INTRODUCTION

In the first chapter of this study, the background, rationale, and the significance of the study will be presented. Then the purpose of the study will be mentioned followed by the research questions, research hypotheses, and research limitations. In the last part, the definition of terms will be expressed to clarify the essential terms.

1.1. Background of the Study

Successful execution in all kinds of sports needs a high level of perceptual capacity and also an efficacious performance of motor behavior. High-level players are considered by intense spatial and temporal restrictions imposed on the player by regulations and the opponents in sports (Williams, Davids, & Williams, 1999). Under such restrictions, a performer's ability to precisely and rapidly perceive related information will help decision making, organization of motor behavior, and allocate more time for preparation in the area of sports performance (Houlston & Lowes, 1993; Ripoll, 199).

With respect to execution of motor skills in a proficient manner, high level of perceptual skills and good performance of motor behavior are required in approximately all of sport types especially those requiring interceptive actions (i.e. striking, hitting, & catching) (Mori, Ohtani, & Imanaka, 2002; Akpinar, Devrilmez, & Kirazci, 2012). Approximately the majority of racket sport players & fastball games are supposed to receive, shoot the ball at the exact place and accurate time to throw the captured ball to the desired position of the opposite ground intercept, &

ultimately to be victorious in the field of mastery world. In fact, the course of the ball depends on the timing of the stroke and its contact site. Moreover, in order to intercept or hit at the required position, male and female athletes should have the ability to exactly forecast the speed of the coming ball and its direction to diagnose the correct target in space (Williams, Davids, Burwitz, & Williams, 1994).

It should be mentioned that Coincidence anticipation timing (CAT) considered an argumentative issue among the notions of cognitive performance in an individual's daily life. For example, making fast reactions as well as interceptive actions like catching or hitting a ball requires perfect anticipation ability. Thus, the ability to predict the exact ultimate arrival position of a moving object in time and space is accepted as CAT ability (Lyons, Al-Nakeeb, & Nevill, 2008; Sanders, 2011). Coincidence Anticipation Timing is viewed as the potency to forecast an object while it would achieve at a target point in space and time (Williams, Davids, & Williams, 2000). Sanders (2011) defined CAT as the ability to judge when a moving stimulus will arrive at a target and he believes that human makes these decisions when they shake hands, grip a ball, etc.

In the majority of racket sports like badminton, for the case, it is very crucial to follow the badminton ball movement, in order to anticipate the arrival of the coming ball, and on the other hand, striking the ball toward the other side of the court. Particularly in sports that need accurate hitting or catching, anticipation could be considered as an important factor that may lead to a favored exhibition (Magill, 2004; Schmidt & Lee, 2005). Also, the CAT has been regularly applied to test athletes and select talented individuals (Ripoll & Latiri, 1997). Coincidence anticipation task is seen as types of anticipation or as a part of anticipation (Poulton, 1957). The mentioned investigator also added that the Coincidence anticipation is composed of two forms of anticipation: effector anticipation (indicating the ability of people with respect to duration that they move their

limbs), and receptor anticipation (indicating the ability that how long it will take an external event to occur). McMorris (2004) declared that the Anticipation itself has three divisions: as an event anticipation (relates to what will take place), perceptual anticipation (based on the situation, it consists of one or the entire anticipations); spatial anticipation (connected with the situation or where an event will occur), and finally temporal anticipation which refers to the time or in the other word when an event will occur.

In the case of measuring of CAT, one of the recent studies Ak & Koçak (2010) declared that CAT facility or in the other word (reaction accuracy) should be measured by the difference in the time spacing between the participant's response-ability and the arrival of the approaching ball at the exact target. At this point, this question arises: how CAT should be evaluated? To answer to this question, we can mention numerous articles recommending that Bassin Anticipation Timer (BAT) apparatus can be useful in this respect (Lyons et al., 2008; Akpinar et al., 2012; Duncan et al., 2013; Kim, Nauhaus, Glazek, Young, & Lin, 2013). Akpınar, Devrilmez, and Kirazcı (2012) mentioned that BAT is generally employed in the assessment of CAT (Magill, Chamberlin, & Hall, 1991; McNevin, Magill, & Buckers, 1994; Williams, et al., 2002; Coker, 2005). Also, in the review by Sanders (2011), it is authenticated that twenty-nine articles applied to this machine from 1980 to 2011. Furthermore, in the study of Abernethy and Wood (2001) which observed the impact of different workout programs on sport-specific motor execution, the outcomes showed that BAT can be a suitable device to justifying CAT and being successful in sports for both females and males. Moreover, Nettleton and Smith (1980) tested the reliability of the BAT and found reliable at different stimulus velocities. The BAT composed of three sections of the runway (2.24 m) which connected to a controller that caused the lights to turn off and on) with the system's LED lights (49 lamps). Correspondingly to respond anticipating the arrival of the light a button (in the modified one which was applied in the presented study, the racket was used

instead of a button) was located to use by participants. The speed of the lights which were turned off or on shows the different stimulus velocity (Akpınar, et al., 2012).

The ability to predict an approaching ball or oncoming objects seems to be an essential conception in performance and reaction accuracy in sport fields where conditions and environments are unpredictable and non-consistent in the course of action (open skills). Beside of this, it was mentioned that CAT task is momentous in sports which composed of the uncertainty that the management of the movement talent or skill is not figured out by the player himself or herself, but by the environment like receiving a serve in tennis or receiving a pass in basketball (Duncan et al., 2013; Singer, Cauraugh, Chen, Steinberg, & Frehlich, 1996). For that reason, it can be concluded that the anticipation issue can be seen as the most significant factor in terms of open skills' in the performance of sports (Williams, Katene, & Fleming, 2002). Ripoll and Latiri (1997) mentioned that the CAT has been widely used to test the participants' visual accurateness or their eye-hand coordination in terms of the election of gifted and talented players in the world of sports. The perfect and victorious CAT performance relies on the anticipation of moving ball or object in the accurate moment, and the situation of the ball or object as a response accuracy and finally suitable body movements against the ball/ object. If not, false or biased perception of the coming ball could affect the temporal error in sports (Meeuwsen, et al., 1997), which may lead to fails in competitions or undesired performance in contests (Ak & Koçak, 2010).

Nowadays, investigators applied many techniques or methods to investigate the CAT in order to make considerable progress in an individual's understanding of this subject regarding distinct characteristics. For that reason, a large number of researchers studied the efficacy of multiple distinctive areas like different ages, gender differences, fatigue effects, different skill level of participants (novice-

Experienced), sedentary conditions, different stimulus speed (low, moderate, high) and various exercise intensity (1, 3, & 5) on Coincidence Anticipation Timing ability in sport science. In this respect, Benguigui & Ripoll (1998) declared that CAT ability could be enhanced or weaken by some agents and variables. Also, they mentioned that the combination of aging and experience background of participants may affect perceptual-motor progressions. In the case of expertise, so many factors can discriminate players of different sports from novice to experience. In this vein, studies addressing the effect of sports background and the participant's experience level like the intensive practice of fastball games (tennis; badminton) have shown that practiced participants are more valid in coincidence timing than novices (Bowers & Stratton, 1993; Brady, 1996; Ripoll & Latiri, 1997). Researchers mentioned that experienced participants could be capable to exhibit upper state of decision-making, tactical and technical abilities, also, some of the investigators said that skilled and experienced participants generally have higher dynamic visual perception than novices or beginners. With respect to the CAT task, experienced participants also anticipate more precisely, rather than novice participants (Lyons et al., 2008). Evidently, the skill of CAT may possibly differentiate experienced and less skilled participants, as highlighted in advance (Ishigaki & Miyao, 1993). Anticipating the velocity of the coming ball and its tracking is fundamental in sports especially which needs hitting (e.g., tennis, badminton). Performers of these types of sports need high-quality of anticipation timing capability to execute the needed footwork, or to be prepared for a return shot and to get the accurate position. Moreover, the contact position of the moving ball with the racket & deciding the path of the coming ball as it is sent to the competitor’s side is essential otherwise the small change in timing may affect the ball on the undesired position of the court (Ak & Koçak, 2010). Therefore, CAT is one of the most essential skills needing progress by the performers of the mentioned sports. With this background, the present study tries to discover the effects of some essential factors like (experienced- novice, stimulus speed, exercise intensity, and sedentary) on badminton players to answer

some questions with respect to anticipation timing accuracy which was not studied before.

Badminton is a racket sport that can be played individually next to a single opponent or between two teams of two players each (doubles). Each performer makes use of a badminton racket that is strung with cord to strike a hollow rubber ball covered with felt over or around a net and into the opponent's court. The aim of the game is to play the ball in such a way that the opponent is not able to play a good return. The opponent who is not capable to return the ball will not gain a point, while the opposite opponent will. This sport needs a broad range of fast limb movements to persuade rapid alterations or modifications at various locations on a playing court (http://emasports.weebly.com/badminton.html). By regarding the dimension of the playing court and the speed of the moving ball in badminton with respect to testing CAT, we should choose the proper stimulus speed in BAT which represents the actual performance of the badminton players. According to Ferrauti and Bastiaens (2007) and Iino and Kojima (2009), the space between two baselines in badminton is about 13,4 meters and back boundary lines (20 feet/6.1-meter width) which are parallel to the net. The mean speed of the moving badminton ball in the course of an adult game is something like 100 km/hr. (27 m/sec.) and much slower in teen badminton players. By using this information, it can be concluded that the participants have less than 1 second to get ready for the return shot after the opposite competitor hits the ball. Considering the variations in the speed of the ball and distance between participants, CAT should be assessed by the various stimulus speeds (low, medium, & high). Therefore, in the present study different velocities will be used to test the CAT.

Researches on sex differences in CAT show that, generally, males execute faster with fewer errors; but outcomes are conflicting. With respect to gender differences, the effect of sex on CAT accuracy shows that male's CAT accuracy is better and less

variable than that of females (Dorfman, 1977; Haywood, Grenwald, & Lewis 1981; Bueckers, Pauwela, & Meugens, 1988; Dunham& Reeve, 1990). However, some research results show no significant differences between male and female' performances (Petrakis, 1985; Weisberg & Mead, 1983). In the study of Ak and Koçak (2010), it was hypothesized that male players would have lower CAT accuracy than females due to the differences in motor factors (Wrisberg, et al., 1979).

1.2. The rationale of the Study

Today's, it has been demonstrated that to a proficiently perform motor skills in nearly all of the sport types involving open skills (e.g. handball & volleyball) in which accurate CAT presents a major function to grab, intercept, and strike a moving ball, there is a huge claim for high rank of perceptual skills. Especially, sports like tennis, table tennis, squash, and badminton demand a high-quality execution of motor behavior and perceptual ability (Mori, Ohtani, & Imanak, 2002). With respect to the ball games (badminton, tennis) and their performers, it can be said that practicing ball games can facilitate some participants to progress their motor improvement faster than others. Benguigui and Ripoll (1998) compared 7, 10, 13, 23 years old tennis participants on CAT and the results indicating that tennis participation can improve perceptual-motor progress, also 7-year-old experienced tennis participants had superior scores than 7-year-old beginners on CAT task.

With regard to the effects of gender differences on CAT, investigations showed that, generally, females perform slower and higher errors; but results are contradictory. Totally, a massive improvement has appeared in the case of CAT from a huge number of studies that have been carried out on this issue in terms of different and various fields like sex differences, sports background, expertise, experience level, and the quality and quantity of practice. The study of Sanders (2011) showed that there was a small number of experiential records which studying the effect of sex on CAT as well as knowing of sport characteristics in the literature also, this study

added that by comparing males and female participants; male participants generally had superior execution on coincidence anticipation tasks than female participants, but still there are several ambiguous investigations on anticipation in terms of sport participation and gender differences. Moreover, a small number of studies conducted in regard to determining the effect of sport participation (experienced, novice) differences on CAT in teenagers and adolescents (Sanders, 2011). Hence, there is probable to be a huge gap of CAT in the literature and choosing various sports participation of youngsters would be a conceivable variable in the presented study because of this absence. Several investigations have revealed a superior accuracy on the CAT acquired from professional athletes when matched up to the beginners (Tenenbaum, Sar-El, & Bar-Eli, 2000; William & Starkes, 2002; Lyons, Al-Nakeeb, & Nevill, 2008). This better exhibition of experienced players may hold the idea to apply the CAT for talent participants' recognition. studies of CAT have generally concentrated on the differences between skill levels of participants (Tenenbaum, et al., 2000; Rowe & McKenna, 2001; William & Starkes, 2002; Del Villar, Garcia Gonzalez, Iglesias, Perla Moreno, & Cervello, 2007; Lyons, et al., 2008). The outcomes of these investigations mostly demonstrated better CAT accuracy for practiced and experienced players than the beginners. To date, considerable signs of progress have been made in knowing of CAT with regard to sex differences, practice effects, different stimulus speed testing, different exercise intensity, and experienced-novice differences. However, there are only very few studies that were purposed to point out the differences of CAT with respect to all mentioned factors in badminton sport. It should be added that this study tries to extend the prior studies carried out by Lyons et al. (2008) and Duncan et al. (2013) in which they studied the effects of various exercise intensities (fatigue) on CAT task with regard to different stimulus speeds and skill level of participants (novice- experienced). Nevertheless, the effects of the sedentary condition of participants on CAT have not been studied.

1.3. Purpose of the Study

The purpose of this study was to examine the effects of different stimulus speed, different exercise intensity, and experience level (experienced, novice, and sedentary) on coincidence-anticipation timing (CAT) performance of adolescent badminton players.

1.4. Research Questions

The followings are the research questions that were formed with regard to the purpose of the study. Therefore, the research questions are:

***For Stimulus speed (1, 3, & 5) and Experience Level (experienced, novice, & sedentary) at rest condition*:**

- Is there a significant interaction between stimulus speed and experience level on CAT at rest condition?
- Is there a significant difference between stimulus speed and experience level on CAT at rest condition?

***For Exercise intensity (70%), Stimulus Speed (1, 3, & 5) and Experience Level (experienced, novice)*:**

- Is there a significant interaction between exercise intensity (70%) and experience level (experienced, novice) on CAT?
- Is there a significant difference between exercise intensity (70%) and experience level (experienced, novice) on CAT?
- Is there a significant interaction between stimulus speed (1, 3, & 5) and experience level on CAT at 70 % exercise intensity?
- Is there a significant difference between stimulus speed (1, 3, & 5) and experience level on CAT at 70% exercise intensity?

For Exercise intensity (90%), Stimulus Speed (1, 3, & 5) and experience level (experienced & novice)

- Is there a significant interaction between exercise intensity (90%) and experience level on CAT?
- Is there a significant difference between exercise intensity (90%) and experience level on CAT?
- Is there a significant interaction between stimulus speed (1, 3, & 5) and experience level on CAT at 90 % exercise intensity?
- Is there a significant difference between stimulus speed (1, 3, & 5) and experience level on CAT at 90% exercise intensity?

1.5. Hypotheses

The hypotheses of this study were shaped with respect to the mentioned research question as follows:

***For Stimulus speed (1, 3, & 5) and Experience Level (experienced, novice, &sedentary) at rest condition*:**

- There is no interaction between stimulus speed and experience level on CAT at rest condition.
- Stimulus speed and experience levels do not have significant effects on CAT in badminton participants.

For Exercise intensity (70%), Stimulus Speed (1, 3, & 5) and Experience Level (experienced, novice):

- There is no interaction between exercise intensity and experience level on CAT at 70% exercise intensity.

- Exercise intensity and experience levels do not have significant effects on CAT in badminton participation participants.
- There is no interaction between stimulus speed and experienced-novice on CAT at 70% exercise intensity.
- Stimulus speed and experienced-novice do not have significant effects on CAT in badminton participation participants.

For Exercise intensity (90%), Stimulus Speed (1, 3, & 5) and experience level (experienced & novice)

- There is no interaction between exercise intensity and experienced-novice on CAT at 90% exercise intensity.
- Exercise intensity and experienced-novice do not have significant effects on CAT in badminton participation participants.
- There is no interaction between stimulus speed and experienced-novice on CAT at 90% exercise intensity.
- Stimulus speed and experienced-novice do not have significant effects on CAT in badminton participation participants.

1.6. Significance of the Study

A key reason for the essence and progressing development of the body of knowledge throughout the investigation in physical education & sports is to develop motor skill ability (Wilson, 1991). Actual life experience proposes that people react most precisely to lower stimulus speed or longer stimulus speed-length where their responses are relating with coincidence anticipation. This result seems obvious in racket sports, football, handball, etc. (Wilson, 1991). Up to date, so many investigations have been conducted in the case of CAT with regard to different variables (different sport types, training methods, age, exercise intensity, various

stimulus speeds, gender, etc.). With respect to literature, it can be seen that there is a gap in experienced-novice differences, sedentary conditions, and sex differences in CAT at different stimulus speeds and different exercise intensities. Even if some researchers showed that male participants, in general, had superior performance on CAT tasks than female participants, but there are still some unclear and ambiguous results regarding sex effects, experienced-novice condition on CAT performance. Moreover, few researchers have been carried out in the case of measuring the CAT task of youngest or adolescent (Sanders, 2011).

The main philosophy of proposed study was formed regarding to the recent studies which have been conducted to evaluate the impact of different exercise intensities (rest, 70% or 90% HRR) of different skilled participants on CAT task (Lyons et al., 2008), various stimulus velocities such as 1 mph, 5 mph (Duncan et al., 2013) and also found gap with respect to CAT on sex differences particularly among different age range of adolescents. Physical activity level effects, sports participation (for example tennis) have not been tested in a CAT paradigm, while sports participation and physical activity level could have been an essential variable on CA timing studies (Haywood, 1989).

The similar process with a few changes in variables (experienced- novice tennis players, different speed velocities) of measuring CAT under different intensities such as low, moderate, and high may raises the similarity between proposed study and mentioned studies' (Duncan et al., 2013L; Lyons et al., 2008) results, consequently, the results that will be gained can be seen special, & unique, which truthful due to the characteristics of evaluating Coincidence Anticipation Timing task. To sum up, this proposed study tries to examine the effects of different stimulus speeds, different exercise intensities, sedentary conditions and experience level (experienced and novice) on coincidence-anticipation timing performance of adolescent badminton players.

1.7. Limitations

This study has potential limitations as the daily activities of the participants could not be controlled.

1.8. Operational Definitions

The stated explanation of the terms was used by the current study as follows:

Coincidence Anticipation Timing (CAT): “the ability to forecast the arrival of a moving object or ball at a particular point in space and coordinate a movement response with that arrival” (Payne, 1986).

Experienced Players: “one whose performance shows consummate skill and economy of effort and special skills or knowledge derived from extensive experience with sub-domains” (Hoffman, 1996).

Bassin Anticipation Timer (BAT): CAT ability has been typically calculated by using this equipment (Sanders, 2011).

Badminton Players: All players who have participated in the presented study regularly took part in badminton training at least three days a week with a minimal three years background of participation and they were orderly attended in national competitions of badminton tournaments.

Absolute Constant Error (|CE|): Represents "the absolute value of the constant error" (Schmidt, 1988, p. 60).

Variable Error (VE): "the variability of the subject about the mean response" (Schmidt, 1988, p. 58).

CHAPTER 2

LITERATURE REVIEW

The effects of different exercise intensity (Rest, 70%, & 90% HRR) and different stimulus speed (1, 3, & 5) on the CAT task with respect to the experience level of adolescent badminton players and sedentary participants were examined in the present study. This chapter was included to emphasize and better comprehension of previous results of main notions which highlight the effects of some factors that may influence CAT task in sport fields or normal life. In this vein, firstly some definitions of CAT and its measuring device characteristics were provided and then the effects of gender, experience level, different stimulus speed, and different exercise intensity on CAT were presented to show the literature that exists in regard to presented study.

2.1. Coincidence Anticipation Timing & Bassin Anticipation Timer

The ability to forecast (anticipate) is an essential fundamental process in the execution of open skills, where the skill is dynamic and externally fast-paced because of the variable condition and environment (Rothstein & Wughalter, 1987). Payne (1986) defined CAT as the capacity to anticipate the arrival of a coming ball or an object at a specific place in space and synchronize a movement reply with that arrival. It is necessary for many activities within sports movements involving striking, catching a ball, etc. CAT has been broadly applied to check eye-hand coordination in line with selecting talented and gifted participants of sports (Akpinar et al., 2012). With respect to the study of Stadulis (1972), it can be said that CAT implies two phases of interception manner. The initial part includes

making a motor reaction at the same time while the coming ball or an object appears at a selected place (coincidence) on the other hand, the next phase deals with initiating a reply prior to the coming of the moving ball at a chosen interception place to keep away from a delayed reply caused by reaction time (anticipation). CAT is therefore significant in externally paced sports including hesitation (Singer, Cauraugh, Chen, Steinberg, & Frehlich, 1996). Also, CAT needs precise achievement of 3 stages: (1) a sensory stage where sensory data is employed to identify, correct and direct motor activities (Goodgold-Evans, 1991), (2) a sensory-motor combination stage through which the place and time of the receiving stimulus and the motor reply are determined, & (3) the implementation or motor stage (Fleury & Bard, 1985). So, it can be concluded that CAT is an essential factor that should be considered in the field of sports or normal daily life and it should be tested and measured. In this respect, the Bassin Anticipation Timer (BAT) apparatus has been widely used to measure the CAT task by 29 studies (Sanders, 2011). BAT device has three parts: a control console, a response switch (in the presented study modified BAT was used which has racket instead of a button), & one or more sequential runways with a linear series of movement-simulating LED lights. While the lamps are light up in series, contributors are wanted to push the response switch (kick with the racket) when they predict the last lamp will light up (Kim et al., 2013). So, two different responses may appear: a) Early responses indicating negative mark and b) delayed responses indicating a positive mark in direction. Beside of this, it should be mentioned that in the case of measurement of errors, 3 different error scores a: accuracy of CAT results calculated by absolute error (AE), b: variable errors (VE) demonstrate the variability of scores; c) constant error (CE) was widely used in statistical analysis with respect to CAT task.

2.2. Effect of Different Exercise Intensity on CAT & Fatigue

In spite of important progress in understanding the CAT task conceding training effects, sex differences and experience level differences, many undetermined issues still remain. One of those unanswered questions relates to what are the effects of fatigue on CAT? The importance of the CAT task in the world of sport is obvious, however, only a small number of studies have inspected fatigue properties and exercise intensities on CAT performance.

Bard and Fleury (1978) studied the impact of fatigue by using a bicycle ergometer on CAT and results showed no significant difference in Absolute Error with tiredness. Also, Fleury, Bard, and Carrière (1981) applied a physical and perceptual activity to persuade fatigue and found that fatigue had no effect on Absolute Error or variable error. Moreover, Fleury and Bard (1987) studied the impacts of various sorts of metabolic tiredness by applying a running protocol (using a treadmill) on CAT which showing that the various tiredness types had no main impact on different error types.

Recently, Al-Nakeeb et al. (2005) studied the impact of various exhaustion rates (70% HRR as a Moderate & 90% HRR as a high-intensity) on anticipation in beginner and experienced performers (18 participants from ball games, racket sports, & ice hockey) by using running ergometer to get the desired heart rate. Also, Basin anticipation timer device was utilized at three various stimulus speeds (3, 5, & 7 mph). The obtained raw scores were transformed into 3 different measurement errors as an absolute error, constant error, and variable error. With respect to statistical analysis, there was no significant difference in constant, variable, and absolute errors at rest, following 70% HRR & 90% HRR intensities level. Also, there was no main difference in the CAT exhibition with respect to the beginners and experienced level players. The outcomes of this study seem to imply that effort had a partial or very low impact on the cognitive features concerned with the ability to

anticipate a moving ball/light/ target. Following the mentioned study, the same authors; Nakeeb and Lyons (2007) studied the cause of various types of exercise intensities a) 50% HRR as a moderate and 80% HRR as high-intensity fatigue levels on CAT task by recruiting 20 physically-active male participants. And the outcomes were still the same as their previous study which indicated that there was no significant difference in Coincidence Anticipation Timing presentation with respect to different exercise intensity levels (Rest, 50%, & 80% HR). By knowing these outcomes, it comes to mind that still fatigue impacts on CAT are not clear and ambiguities stay behinds the impacts of different exercise intensity or fatigue levels on Coincidence Anticipation Timing performance. It seems that these unclear outcomes are partially related to examining the procedure of the cognitive performance on exercise ending rather than within intensity of exercise (Lyons, Al-Nakeeb, & Nevill, 2006a, 2006b; Duncan et al., 2015).

As cited before, a large number of studies were conducted by Fleury, Bard, and their colleagues by studying the effects of different exercise intensity levels on CAT tasks. However, there are still some unanswered questions that remain in this respect and the acquired results are conflicting with each other. One of the most recent investigations which considered the influence of various exercise intensity levels (at rest, 70% HRR, & 90% HRR by running on a motorized treadmill) at three different stimulus speeds (3, 5, & 8 mph) on CAT task by recruiting eleven male and three female participants and using BAT device as a measurement tool; after transformation of obtained row scores into 3 error measurements (constant, absolute, and variable errors) indicated that different stimulus speeds acts together with the effect of different exercise intensity level on CAT. And there is no significant difference between the entire exercise intensities at a 3-mph speed (Duncan, Smith, and Lyons, 2013). The same results with the same protocol of procedures were seen in the study of Lyons and colleagues (2008).

Exhaustion or Fatigue is a subject that has a critical role for exercise physiologists, sports researchers, & trainers. Fatigue represents humbling and distasteful exercise to the people who have involved in sustained and intense activities (Green, 1997). Fatigue is challenging as the complexity in separating the mechanism for the incapability to complete movement or performance in sport amongst a difficulty of variations in the compound systems, cell, and biological structure of the human organs (Green, 1997) also it is a compound and involves a range of behaviors that are special to any conditions (Gawron French & Funke 2001). Fatigue is specifically significant in the sports field, reducing the risk of injury, and decreasing muscular performance. Bompa (2000) believes that fatigue has a negative role in the performance of players, and the probability of losing the match or poor performance is very high for the participants who cannot handle activities effectively with fatigue; moreover, it negatively decreases the ability to focus in technical and tactical issues in the field of sports. Mckenna (2003) believes that variations in the levels of fatigue among players within a group activity may represent which participant gets to the goal first, which presenting successful performance and effects the results, thus it may be a vital factor in the final sets in badminton match or other sport types. Additionally, in the field of sports, participants need to execute simultaneously, a high perceptual, physical and decision-making task under a high physical activity (Goderfroy, 2002). In this respect, Mcmorris (2004) mentioned that there is a lack of investigations in the importance of fatigue on the performance of players, so, the impacts of fatigue are a subject that merits additional investigation.

Fatigue defined as the connected outpour of intellectual & physiological tasks (Tatakuwa, 1971). Muscular fatigue explained as “the inability to generate a required or expected force” (Green. 1990, p, 14), so it can be the point at which a special power can no longer be sustained and shows the inability to keep the needed or expected power output. Bigland-ritchie (1984) defined exhaustion as any

decline in participant's ability to apply force in reaction to intentional exertion, regardless of whether or not the activity itself can still be executed effectively. Also, fatigue can be seen as the improvement of less than the normal power or strength as a result of muscular movement or activation. Fatigue would represent the situation that rises in either the central nervous system or muscular that contribute to the start of fatigue. As a final point, researchers defined fatigue as 'the state of an organism's muscles, viscera, or central nervous system, in which prior physical activity and/or mental processing, in the lack of adequate rest, results in inadequate cellular capacity or system-wide energy to keep the needed levels of activity and/or processing by consuming normal resources' (job and Dalziel, 2001, p.469). In the presented thesis, with respect to different definitions of exhaustion, the statement of exercise intensity will be accepted in the study, which shows that the physiological influence of training can be tested.

Aks (1998) mentioned that different outcomes in the systematic literature reviewing the impacts of various types of exercise intensities on the exhibition of players reflect huge differences in the forms of tasks applied (response time, motor, and sensory). Methods are also were not the same in terms of the level of intensity, type of exercise, duration and the criteria representing different outcomes (McMorris & Keen 1994). To sum up, week performance resulting from the level of exercise or amount of fatigue may be different by regarding the tested muscle types, contraction, intensity, and duration of the activity. With respect to these various factors, loss of power or strength may originate from different parts from the motor cortex through to the contractile muscles and elements.

2.3. Effects of Experience Level on CAT

It is generally recognized that in sport fields, there are numerous aspects that differentiate experienced and novice players. In this respect, Tenenbaum, Sar-El and Bar-El (2000) mentioned that experienced participants possess the capability to

employ environmental signs more precisely, choose suitable reactions more rapidly (Helsen & Pauwels, 1993), manage provisional variability more expertly (Bootsma & Van Wieringen, 1990), & predict or anticipate motions more correctly & better within a various of fastball sports.

A large number of studies have been inspected in order to see skill level differences of different samples in the CAT task during recent decades (Williams, Davids, & Williams, 1999, p. 97). However, several investigators said that there is a huge need for research investigating the impact of sports background and skill level within the literature. Even though some articles dealing with the impacts of experiential issues demonstrated that expert sport participants can execute much precisely than beginners with respect to the CAT performances, there are few contradictory outcomes through existing literature. While scholars assumed that expert players were better & more precise and had lower variability than beginners. On the other hand, other researchers pointed out that there were no considerable differences between skilled athletes and novice ones, particularly when the movement characteristics of the moving ball or object are alike to the ones connected in their field of movement (Benguigui & Ripoll, 1998; Lyons et al., 2008). While other studies mentioned that there is no significant difference between experienced & beginners (Del Rey, Whitehurst, Wughalter & Barnwell, 1983; Dunham, 1989; Etnyre, Glasscock, Krejci, Ogden, Stiner & Vanderkay, 1992).

Furthermore, current investigations would help us to comprehend some differences between novices and experienced players. For example, the study of Bowers and Stratton (1993) concluded that NCAA Division I level baseball participants were better & precise than Division III level participants on CAT performance, on the other hand simply for the simulated rapid ball runway speed of 38.00 m/s and there is no statistically significant difference found between first-level Division & the third level Division participants on a stimulus speed of 33.53 m/s. The same results was

seen by the study of Brady (1996), who demonstrated that 'open skills players' (football, tennis) were more accurate while comparing with 'closed skills players' (track & running) and sedentary people, except merely on rapid speeds (i.e., 5.36 and 6.71 m/s vs. 2.68 and 4.02 m/s) indicating that expert players' had advantage in CAT tasks emerges while the movement characteristics of the coming stimulus are similar to which the participants were faced with the type of training.

The study of Ripoll and Latiri (1997) which evaluated participants execution of practiced table-tennis and beginners in a CAT task by using constant velocity trajectories (4.17 m/s) & different decelerated trajectories (8.32 m/s to 4.17 m/s, i.e., 6.5 m/s2) indicated that beginners were more trajectory-dependent than professional athletes and had minus accuracy in the deceleration situation. They mentioned that to understand the origin of the obtained differences, it is to suppose that while the speed of the trajectory is inconsistent, the CAT performance turns out to be more complex and the accurateness of the reaction relies on the efficiency of the perceptuo-motor skills. On the other hand, the study of Tresilian (1995) recommended that the source of the perceptuo-motor coupling might become more explicit with rehearsal, so the upper accuracy in the deceleration situation among professional participants might be the product of an explicit skill to more exactly coordinate participants reactions to the appearance of coming object on the desired target.

One of the recent studies that used the BAT device to test the CAT task with respect to sports background and skill level of participants was mentioned that, in general, skilled ones are better and more accurate & less variable by comparing to the beginners on Coincidence Anticipation Timing performance (Akpinar et al., 2012). Other researchers have also mentioned that experts have a superior CAT skill in reactive sport types like tennis and badminton which needs appropriate interceptive behaviors such as striking or catching than beginners

(http://www.d.umn.edu). In this respect, the study of Benguigui and Ripoll (1998) also hold up the prior results that expert ones are better than novice players on Coincidence Anticipation Timing just if the nature of the coming stimulus is precisely parallel to that faced with the kind of sports that players participated in. In most cases, expert participants have the ability of showing a higher level of needed technical & tactical, decision-making ability, also perceptual skills which distinguish expert players from beginners (Lyons et al., 2008) and professional players possess a faster and better reaction time while comparing to sedentary participants or beginners (Ak & Koçak, 2010). In point of fact, the accurateness of CAT performances differentiates professional and novice players. Naturally, players with a superior rank of CAT capacity might be capable of understanding the exact location of the coming ball in the interval space and they can be prepared themselves at the exact location to handle a response to the other part at the chosen mark. As a result, we can finalize that CAT ability is one of the critical issues needing improvement by the players to be an expert one.

Lyons and colleagues (2008) conducted a study to see the impact of various exercise intensities by applying three different conditions a) rest, b) moderate: 70% HRR, and c) high: 90% HRR on CAT, indeed they are eager to know the effects of sport experience (differences between beginner and professional) in Gaelic games in terms of post-exercise explanations on CAT task. Eleven expert Gaelic players and nine novice players were engaged in the testing procedure by using BAT as a measurement apparatus of CAT skill at the mentioned 3 exercise intensities with a constant stimulus speed of 5 mph. The steady running procedure on a mechanical treadmill was used to gain the mentioned heart rate reserve of players. To apply an actual task to simulate shooting a ball, as a substitute for touching the switch button, players completed steady swing by using a standard Hurley throughout a photoelectric glow of the BAT device. It should be mentioned that during the testing procedure each player was measured instantaneously after every different exercise

intensity (20 trials). Gained scores were evaluated as a constant error, log variable error, and absolute error. With respect to the results of absolute and log error, it can be seen that expert participants performed better CAT task than the beginner ones at whole different exercise intensities. Moreover, the investigators of this study concluded that expert Gaelic players could preserve the ability of CAT at 3 various exercise intensities, while, beginners can do their best just at 70% HRR.

The study of Ripoll and Latiri (1997) explored the impact sports experience (experienced and novice table tennis participants) on CAT. All Participants were tested by applying 2 different situations (stable speed and steady deceleration). This study mentioned that there was no training impact under stable speed; however, there was an impact of practice level under deceleration situation indicating that practiced table tennis participants were better & more precise than beginner tennis players. Also, with respect to visual information processing features, the outcomes established that practice level can discriminate professionals from other players.

To see the effect of different sport types on CAT, Akpinar and his colleagues (2012) conducted the study within various stimulus speeds (1, 3, & 5 mph) by recruiting three various racket players (table tennis, tennis, & badminton) by applying BAT machine. 15 males and 15 females involved for each racket sports. The outcomes of this study indicated that stimulus speed and racket sports had a significant result in both types of errors (variable and absolute), also tennis participants performed an accuracy than other players at 1 mph speed. Moreover, badminton players had poorer CAT consistency than tennis participants at 3 mph stimulus speed and at 5 mph speed table tennis participants showed inferior accuracy and consistency than tennis participants. So, we can conclude that participants from different racket sports need various motor skills in the CAT task. In line with this study, Lyons, Al-Nakeeb, Hankey, and Nevill (2013) conducted a study to see the effects of various exercise intensities (70% & 90% peak heart rate, and) on the accuracy of CAT by

recruiting professional (13 participants; 7 boys and 6 girls) and beginner (17 participants; 13 boys, 4 girls) tennis players. The outcomes of this study mentioned that there was an important difference between CAT accuracy at no-exercise condition contrast to a higher level of exercise intensity. On the other hand, there was a main exhaustion effect & there was no exhaustion and experience level interaction. Moreover, there was a great reduction between professional and beginner participants at 90% exercise intensity and experts had precise attempts through whole experimental situations.

2.4. Effect of Different Stimulus Speed on CAT

The effect of various stimulus speeds on the CAT task has been viewed as one of the most important factors in the field of sports a separate variable and took the interest of many investigators to get valid results in the literature. A large number of researchers have studied CAT under various stimulus speeds with different measuring processes and devices.

In a study of CAT performance of children with the age ranges from 7-12; Dunham (1977) recognized that participants were more perfect while compared with slower stimulus velocity rather than faster ones. With regard to studying the effect of object dimension, speed, track, height, and space on an interception of coming targets or balls, Ridenour (1977) mentioned that the accuracy of feedback is better on a slower rather than quicker stimulus speed. Also, Isaacs (1983) found that coincidence skill of 5 to 6, 7 to 8, 9 to10, and 11 to12 years old were more precise in responses to the slow 7.35 feet per second (ft. /sec) stimulus velocity than the fast (14.70 ft./sec) one. Wrisberg et al (1983) studied the effect of the different stimulus (134.1, 223.5, 312.9 cm/sec with viewing times of 2.2, 1.32, and 0.93 seconds respectively) by using BAT, response switch, and plywood. The motion from button to target was measured consecutively by 5 micro-switches along the path of motion. All participants were evaluated on 9 groupings of stimulus velocity and

motion distance. The results mentioned that there is a raise in stimulus velocity resulted in higher accuracy and lower variability of response. Another study examined the effect of different stimulus speeds (2, 4, 6, 8, & 10 miles per hour) of elementary children on a CAT task by using the BAT device and found that as the speed increased the accuracy of response decreases (Dunham and Reid, 1987).

Payne (1986) conducted a study with respect to coincidence ability of participants age ranges from 9 to 15, and found that all groups in different ages respond most precisely to the middle (150 centimeters/second) stimulus speed when matching up to rapid (300 centimeters/second) or slow (75 msec) one. Dunham and Reeve (1991) studied the effects of gender, and stimulus speed by using the BAT device and by recruiting 15 females and 15 males. The outcomes indicated a major effect for stimulus velocity with responses to the 35 miles per hour stimulus more incorrect than other responses. Brown (1980), studied the impact of different stimulus distance and stimulus speed on CAT capability of college women participants and checked them on compounds of 3 stimulus speed and 3different distances by using the BAT device. Outcomes specified that constant while stimulus speed increases the constant errors increase as well, but the stimulus duration decreases. In line with this study, Shea et al (1981) conducted two trials, by using BAT devices on male and female college participants. In the first test, participants were examined on 6 different stimulus speeds [(1019, 765, 612, 510, 437, 383 milliseconds (msec) durations)]. In the second test, males and females were examined on 2different stimulus speeds (1788 and 3576 mm/sec) over varied BAT runway lengths (1, 2, & 4 segments) which changed stimulus duration. The outcome of the first trial mentioned that participants reacted more accurately when stimulus speed increases and the other test were showed that there was an increase in timing accuracy while reducing stimulus duration from 671 milliseconds to 335 milliseconds.

With respect to the prior investigations, it can be seen that various factors like different age groups and different stimulus velocity may probably affect the CAT task of older adults in a negative manner. With respect to literature, one of the significant studies inspected CAT capability of grown persons at various stimulus speeds (3 and 8 mph) and exercise intensity of 50 %HRR (by walking on a treadmill) by recruiting sixteen (nine men and seven women) physically active participants with the age ranges from 60 to 76 years old and BAT device. The outcomes of the mentioned study specified that, with stimulus speed of 3 mph, CAT ability was developed for the period of nine, eighteen minutes & following exercise in contrast to rest situation, but, the absolute and variable errors were considerably improved at 18 min throughout the training at the speed of 8 mph, indicating a weak CAT performance (Duncan, Stanley, Smith, Price, & Wright, 2015).

Akpinar and colleagues (2012) also, studied the effects of three different stimulus speeds (low=1, moderate=3, & high = 5 mph) by choosing 3 different sports (tennis, badminton and table tennis) & using BAT device on CAT accuracy. The outcomes mentioned that tennis participants had lower absolute and variable errors at low stimulus speed in contrast to moderate and high speeds also table tennis participants had a considerably fewer absolute error and variable error at high speed in contrast to low and moderate speeds. On the other hand, badminton participants had considerably lower absolute and variable errors at moderate stimulus speed in contrast to low and high speeds. Finally, Benguigui & Ripoll (1998) believed that as the stimulus speed is constant, the anticipation of coming ball or an object appears to be easier in contrast to variable stimulus speed.

One of the recent studied conducted a study with respect to impacts of age, expertise level, and sex on CAT by using different stimulus speeds (2.68 m/s =low, 5.36 m/s = high) and applying BAT apparatus to evaluate an accurateness of tennis strokes in CAT performance. By looking at the outcomes of the mentioned study it

can be seen that there was just a significant interaction between stimulus velocity & sex on VE demonstrating that men players were constant than women at 2.68 m/s stimulus velocity also no significant difference reported between male and female at 5.36 m/s stimulus speed on VE supporting the statement that upper stimulus velocity is connected with lower VE (Williams et al, 2002). To sum up, the factor of different stimulus speeds has been studied by utilizing a variety of equipment with varied results regarding the effect of this factor on CAT performance. Possibly the strongest outcome might be obtained from trials which more related to actual life conditions.

2.5. Effect of Gender on CAT

The significance of considering possible sex differences is very important in the field of sport especially in the studies of CAT to see the possible effects that may exist. Insomuch, understanding possible gender differences can help to make appropriate educational programs and to understand cognitive abilities in terms of neuropsychological improvement. Cahill (2006) mentioned that discounting growing results of gender effects on behavior and brain can postpone improvement in the neurosciences. In point of fact, there is a lack of studies that carried out on sex differences in the existing literature. A small number of researchers discovered that there are some probable differences in CAT task between male and female participants.

When choosing a suitable technique to assess the reality of gender differences, result frequency counting was trying to select a meta-analysis procedure. This method has revealed a male improvement for CAT performance that emerges in children as well as in young people & adults. Due to the lack of investigations by applying Real-world exercise to find possible gender differences in CAT, results of studies that applied the Bassin timer with those applying real-world tasks could not be compared. In the laboratory studies, a great number of studies have explored AT

task with the commercially available Bassin Anticipation Timer (Lafayette Instruments). A large number of studies, performance is calculated in terms of error scores with negative scores showing under-estimation of time to arrival and positive values showing over-estimation. In general, writers report one or more of the coming types of error measurements: constant error type (CE), absolute error type (AE), and variable error (VE). Constant error and absolute error calculate accuracy whereas variable error computes precision or consistency.

Thomas & French (1985) recognized three investigations of gender variations in CAT ability (Dunham, 1977; Haywood, Greenwald, & Lewis, 1981; Thomas, Gallagher, & Purvis, 1981) indicating that males are better than females. Nevertheless, there have been conflicting outcomes with some studies showing a small number of female improvements, some no gender variation.

CAT studies have been carried out by researchers interested in fields like child growth, driving skills, educational training, parametric analysis, gender differences, & sports performance skills Sanders (2011). A large number of studies can be seen in regard to sex differences on CAT task in the laboratory system by using Bassin anticipation timer device and it can be said that the studies that carried out on CAT by applying BAT are more than real-world tasks when compared with each other. Other measures involve PC displays, model automobile or balls rolling down an incline, film of moving vehicles, & machine-pitch ball game. The results of CAT mentioned that there was a priority in favor of males in CAT which progressively turn into seen in every child, teenager, adults, & the probable cause for these priorities of male participants would result from biological sources rather than socio-cultural factors (Sanders, 2011). Available studies from the 1970s studying sex differences on the CAT task stated many powerful pieces of evidence of male participant's advantages in cognitive abilities over females (Schiff & Oldak, 1990; Sanders, 2011). Conversely, other investigators established dissimilar outcomes

showing that female participants had superior CAT performance than males and some stating different results for different performance measures procedures.

The study of Dorfman (1977) observed the improvement of CAT by testing 120 participants (males & females) with the age range of6 to 19 years where participants moved a slide control to direct a cursor to intercept a target. Each participant conducted 60 trials. The outcomes mentioned that males were more authentic and less variable than female participants. Despite the fact that the mentioned study informed that there were no meaningful changes in AE, CE, and VE while the goal was invisible prior to the arrival. On the other hand, Dunham (1997) investigated the effects of sex differences, different age range, different stimulus speed, and practice type on CAT performances. 84 male and female elementary school students participated in this study and they were assumed to raise their leg of the switch as they observe the coming ball about to get to the goal in the test process. The same results were seen in the case of accuracy but dissimilar results were seen in variability which indicating that female participants were less variable than males. Besides this, the study of Bard et al. (1981) which included 144 participants age range from 6-11 years old, mentioned the advantage of male participants compared to females in the accuracy of CAT performance. It should be mentioned that the results of 3different test sessions which assessing CAT accuracy with throwing on a target by using complex and simple motor response tasks showed that male participants were better (more temporal accuracy) & less variable regarding the female participants on CAT performance. Additionally, previous investigations, Wrisberg and Mead (1983) tried to find out whether the nature of training experiences influences the growth of CAT performance in 60 young children (6- to 8-years) by applying BAT device on coincidence anticipation ability & hand motion reply by trying to tap the target coincident with the completion of the light sequence. Also, different stimulus speeds that were either slow (4 mph), fast (7 mph), varied-random (4, 5, 6, & 7 mph) were tested in this

respect. The final results showed that male participants had higher CAT ability than female participants only at rapid workouts on AE. While girls performed better than boys at low training on absolute error. In this vein, Fleury and Bard (1985) assessed the CAT performance of 186 male and female participants by using simple and complex tasks and the outcomes showed that male was better than female participants in precisely anticipating in the complex and simple-complex tasks.

Sanders (2011) and other investigators mentioned that male participants usually had superior execution on the CAT task when comparing to female participants, conflicting outcomes and no agreement were seen by prior investigations. Likewise, some other researchers (Williams et al., 2002; Söğüt et al., 2009 stated that, in common, male participants perform correctly less error than female participants on CAT performance. As mentioned before, Söğüt and colleagues (2009) indicated that males had precise CAT performance over female junior tennis players. They evaluated 228 competitive teen tennis participants (118 boys & 110 girls) aged 8 to 10 years old by using Bassin anticipation timer. The outcomes mentioned that male players possessed better CAT ability compared to other participants. Investigators' explanations of their findings have advanced the subsequent basis: (1) differences in participation rates in sports with anticipatory demands (Petrakis, 1985); (2) differences in spatiotemporal skill (Schiff & Oldak, 1990); (3) differences in motoric factors (Wrisberg et al., 1979) (4) impacts of socio-cultural factors (Singer, 1980); and (5) more conservative approach to responding by females (Schiff & Oldak, 1990). Also, there may be age-related causes (Dorfman, 1977; Thomas, Gallagher, & Purvis, 1981). Conversely, other writers (Wrisberg & Mead, 1983; Petrakis; 1985; Ripoll & Latiri, 1997) indicated that there is no main sex effect on the CAT task due to sex variations.

Recently, the study of AK and Koçak (2010) evaluated the CAT of tennis participants and table tennis players (10-14 ages) with regard to probable sex differences that

may exist. Also, the relationship between sports experience and the correctness of the CAT as a dependent variable was evaluated as well. In a few words, they aimed to find the impacts of gender differences and different racket sports on coincidence anticipation tasks by using the BAT device at 2 mph stimulus speed. As participants, 107 male and female tennis players, 42 female table tennis players and 59 male players included. The outcomes showed that there was a significant main effect for both sex and sport types representing that male tennis player among the other 2 racket sports had superior mean CAT accuracy than female participants.

2.6. Effect of Age on CAT

Another issue that has an essential role in CAT is viewed as Age factor and it should be mentioned that this factor has not extensively been examined enough that can be the area of interest for the researchers. By increasing the age of participants especially over sixty years old the physical response against the moving objects and environmental constraints will be difficult and makes a problem which needed in executing CAT tasks (Lobjois et al. 2006). But it can be decreased or improved by practice (Ripoll & Latiri, 1997; Benguigui & Ripoll, 1998; Ak & Koçak, 2010). However, it should be mentioned that the reaction time and information processing of older ones were influenced undesirably by getting older (Söğüt, AK, and Koçak, .2009). CAT would be improved in the childhood period (Williams, .1985) especially in the age range of five to eleven years old (Benguigui and Ripoll, .1998). The other study is in line with the mentioned studies that children at the age of 11 could improve their CAT performance (Kim et al, 2013). Williams et al (2002) were mentioned that the critical improvement on CAT was in the age range of seven to ten. While the other investigators were of the idea that CAT performance continuously getting better with increasing age (Williams et al., 2002). On the other hand, the other study mentioned that CAT ability could deteriorate with age, and the outcomes showed less absolute & variable error types for younger female

participants while performing a switch-press exercise, but the variability of performances significantly improved with stimulus speed in the hitting task. Finally, the results showed that teen and senior females' perceptual frameworks were inversely influenced by influences of the stimulus. (Meeuwsen, Goode, and Goggin, 1997). The other study which examined the CAT performance of participants by throwing a ball and synchronizing the reached location of the tennis ball with reaching of the light stimulus along the runway showed that female participants possessed more temporal & spatial error types than male participants, but, results did not clarify age influences because of the temporal accuracy errors (Fleury and Bard, .1985). Benguigui & Ripoll (1998) mentioned that age may influence perceptuo-motor operations, the accurateness in CAT performance and can be enhanced by the age of participants.

CHAPTER 3

METHOD

As mentioned in the introduction part, the main purpose of this study was to examine the effects of different stimulus speeds (1, 3, & 5), different exercise intensity (rest, 70%, & 90% Heart Rate), and experience level (experienced, novice, & sedentary) on coincidence-anticipation timing performance of adolescent badminton players. So, the needed methodology part was organized to meet this aim by including participants, apparatus, experimental design, and data analysis sub-sections.

3.1. Sampling and participants

For the purpose of the presented study, 139 participants consist of experienced (n=43) with a minimum of three years badminton participation experience, novice (n=42) badminton players, and sedentary (n=54) were engaged voluntarily. According to the literature (Benguigui & Ripoll, 1998; Williams et al., 2002; Ak & Koçak, 2010) teenagers, CAT task would be improved at the age range of five to eleven and the main enhancement was at the age range of seven to ten (Williams et al., 2002; AK & Koçak, 2010). There were 43 experienced badminton athletes (20 boys and 23 girls) participated in this study. Their age ranges are from 11 to 17 years (M=13.20, SD=1.46). They had 4.90 years (SD=1.31) mean experience for playing badminton. Novice badminton group includes 42 athletes (22 boys & 20 girls). Their ages ranged from 11 to 17 years (M=12.84, SD=1.28). Their experience was M=1.50 years (SD= .90). In the sedentary group, there were 54 participants (28 boys and 26 girls). Their ages ranged from 11 to 17 years (M=13.48, SD=1.42). They

did not participate in sports activities for more than 6 months regularly. For that reason, after getting ethical approval from Middle East Technical University the mentioned participants with the age range of 11 to 17 participated in the experiment setting (Appendix A). Experienced players had at least 3 years background of participation in badminton sport and took part in the training sessions (at least three times) per week and in national competitions.

The descriptive statistics of participants are as follows: for the experienced participants, the mean and standard deviation of age and experience level were 13.20 ± 1.46 and 4.90 ± 1.31 respectively. For the novice group, the mean and standard deviation of age and sport participation were 12.84±1.28 and 1.50±.90 respectively. Lastly, for the sedentary group, the mean and standard deviation of the age was 13.48±1.42 (Table 3.1)

Table 3.1 Descriptive Statistics of participants

	Groups	***N***	***M±SD***
Age	Experienced	43	13.20±1.46
	Novice	42	12.48±1.28
	Sedentary	54	13.48±1.42
Experience level	Experienced	43	4.90±1.31
	Novice	42	1.50.±.90

3.2. Data Collection Apparatus

To measure the CAT ability of the participants of this study a Bassin Anticipation Timer device (Model 35575, Lafayette, USA) is utilized which was provided evidence by Abernethy and Wood (2001) to be a suitable and appropriate measurement device in the evaluating process. BAT device is formed of a response button (applied to act in response to predicting the illuminating of the target light), the racket,

control console, and a sequential runway with a frothy-nine linear series of LED lights. As mentioned before a variety of stimulus speeds be tested to do so speed was changed by how quickly the lamps were switched on and off. To set the process 3 sections of the runway (put on table eighty-seven centimeters from the floor) opposite to the participants were utilized. The BAT device was mounted in front of the treadmill to minimizing any postponement from when the required exercise intensity exercise was obtained to act on the BAT. The whole time to conduct the anticipation task was on average 30 s.

This study was applied BAT device because it is generally employed in the measurement of CAT accuracy (Diggles-Buckles & Bassin, 1990; Abernethy & Wood, 2001; Rodrigues, Vasconcelos, Barreiros, & Barbosa, 2009; Sanders, 2011; Rodrigues, Barbosa, Carita, Barreiros, & Vasconcelos, 2012). Moreover, to develop the batting ability of softball participants BAT device seems to be a useful training apparatus (Kuhlman and Beitel, 1992). Also, as cited in Akpinar et al (2012), and Ramella and Wiegand (1983) BAT device seen as reliable and practical equipment to determine errors regarding different stimulus speeds.

3.3. Data Collection Procedures

This study applied a repeated measures design and all processes that used were approved by Ethical Board comity of the Middle East Technical University and signing a letter of approval by participants, their coaches, and their parents, and a copy of the ethics certificate is submitted in Appendix B. These were usually of those applied in the entire of the studies administered here. Participants accomplished letter forms after being completely enlightened of the essence of the study. Each participant was given 10 attempts on the BAT (Model 35575, Lafayette, USA) to be aware of the test procedure. All participants involved in 3 testing sessions and prior to testing sessions, they were given 5 minutes to be ready, warmed-up & execute a sequence of stretches. For the aim of this study, every

participant conducted 3 different trial settings with respect to speed (1, 3 & 5 mph speeds); and three different trial setting with respect to exercise intensity (Rest, 70% HRR as moderate exercise intensity at 1, 3, and 5 mph speeds; 90% HRR as a high exercise intensity at 1, 3 & 5 mph speeds). It should be added that all testing on the different situations was counterbalanced (Appendix C) by recruiting practiced and novice participants under the setting conditions into 3 parts: 1/3 of the players were tested in the order of 70%-90% HRR and 90%-70% HRR with 1, 3, and 5 mph stimulus speeds, 1/3 of participants with the order of 70%-90% HRR and 90%-70% HRR with 3, 5, & 1 mph stimulus speeds and the other 1/3 with 5, 1, & 3 mph stimulus speeds. Also, sedentary participants were just evaluated in rest condition by recruiting them under the mentioned speeds: (1, 3, 5 mph, 3, 5, 1 mph, and 5, 1, 3 mph). Participants of this study were not be allowed to know the speed rate in which they had been tested, or their gained scores on the testing procedure during or after test sessions, by doing this we decrease bias and put a stop to an effect of task complication.

With respect to the nature of badminton as a fast-ball game that requires high-level intensity, CAT was considered in 3 varied exercise intensities (rest, moderate, & high) at three different stimulus speeds (1, 3, & 5 mph speed) to find the experience level differences among badminton participants. To decrease the possibility that the samples might internally point the time trial, cue postponement (visual warning system) was involved as random on the timer with the smallest amount of postponement (1 and the highest postponement of 2 sec) by initiating the signal on side of the experimenter. And participants should use the racket, with their preferred hand, while the coming time of the stimulus at the target place (while lights are illumined in series), as well as they, can. Also, it should be mentioned that CAT evaluations were evaluated in 2 different days with the hour range of 9 am to 7 pm By giving 10 randomly trials at each of the various stimulus speeds (1, 3, & 5 mph) to familiarize participants with the testing procedure. Also, the participants'

performance, error in milliseconds (positive +) or (negative -), was recorded on the BAT, as participants responded prior to the last lamp was light a (-) or early score was pointed out, and while the participant responded after the last lamp was light a positive mark or late score was recorded.

BAT device was mounted in closeness to the treadmill to reduce any lag from when the wanted amount of exercise was attained to complete CAT tasks, which was very significant in respect to mater of limitations in experimental studies since the improvement and recovery procedure following physical work out or exhaustion is in its nature. As a result, the measuring process should be completed without any delay while subjects gained the required intensity condition (70% or 90%); otherwise, it could reduce during this phase (Duncan et al, 2013).

The other factor that is considered in the presented study was the heart rate which was monitored during the testing process by using a Polar device (RS400, Finland). With respect to the studies of (Lyons et al., 2008; Duncan et al., 2013; Duncan et al., 2014; Duncan et al., 2015) which the main part of the presented study designed based on, Resting Heart Rate (HRrest) achieved by preparing the suit place (quiet room) for the subjects to lay in a supine situation at least for 10 minutes. 70% HRR and 90% HRR situations were induced on a running treadmill by applying an incremental running procedure by running speed of 5 mph and after that boosts by one mph every thirty seconds till the subjects arrive at the required exercise intensity (Lyons et al., 2006a; Lyons et al., 2008; Duncan et al., 2013) and the required exercise intensity level should be kept for an extra minute ensuring that subjects were accurately in the needed steady-state exercise intensity (Lyons et al.,2008 and Duncan et al.,2013), while the mentioned HRR was gained the subject was directly allowed to stand (located two meters away from the apparatus exactly in front of the target lamp) and carry out twenty trials at each of the stimulus speeds (1, 3, & 5 mph). With respect to the length of the BAT and different stimulus

speeds, subjects had .44sec, 1.56, 2.2 sec. for low, moderate, and high stimulus speed in each trial, respectively (Akpinar et al., 2012). Also, the obtained scores were kept in milliseconds whether + or negative (Appendix D).

As we mentioned before, 70% and 90% HRR was used in the presented study. It should be added that the exact and most accurate interpreter or forecaster of maximal heart rate (most accurate HRmax) established by Thompson, Gordon, and Pescatello (2009, p. 155) was applied to calculate the needed heart rate. For that reason, HRmax was measured as 206.9 minus the subject's old multiply by 0.67. After that HRrest and HRmax were applied to record & compute 70% and 90% HRR which mentioned in Appendix E (Lyons et al., 2008; Duncan et al., 2013). For example, 70% of HRR is computed as:

$$HR_{max} = 206.9 - (0.67 \times age)$$

$$Target\ Heart\ Rate\ (THR)_{70\%}$$

$$= 70\%\ of\ Heart\ Rate\ Reserve$$

$$(THR)_{70\%} = HR_{rest} + 0.70\ (HR_{max} - HR_{rest})$$

3.4. Statistical Analysis

With respect to motor behavior area (In sport science), the performance of participants could be evaluated by three different sections; a) response size which showing the facts about the movement characteristics like the number of weights in weight lifting b) time; the period of the motion from when athlete reacts to the stimulus like reaction time, and c): accuracy of error; accuracy of the motion which can be assessed by 3 common error scores (variable error, constant error & absolute error). In this respect, the focus of this study is related to evaluating measurement errors of the collected data by expressing raw scores as the standard deviation and mean into a variable error (VE) for consistency and absolute constant

error (|CE|) for accuracy (as a dependent variable). To clarify the dependent variables (|CE| & VE), it can be useful to concisely explain to them as follows:

- Variable error (VE) or consistency: The participant's standard deviation from her or his means response; this shows the variability (consistency) of responses and a high VE means that the performance is inconsistent, while a low VE depicts that the scores are very similar.

- Absolute Constant Error (|CE|): Absolute constant error measures the accuracy of the coincidence anticipation timing scores. High scores show that the performance is inaccurate. Whereas, the less absolute constant error means better performances.

a) Random sampling (participants representing a random sample from the whole participants); b) normal distribution (the DV is normally distributed in the population; c) independence of observations (there is no dependency in the scores between individuals); d) sphericity (variance of the differences between any levels of a within-participants factors are equal across all the groups in the population); e) homogeneity of variance (variability of scores for each of the groups is related) are the needed assumptions underlying Mixed model ANOVA which were assumed.

Homogeneity of variance was estimated due to Levene's test, to prove the quality of variances among the between-participants factor ($p < .05$). On the other hand, Normality tests of dependent variables (accuracy & consistency of CAT performance) at each level of each independent variable (experience level, exercise intensity, and stimulus speed) were analyzed to check the validity of normality assumption by using Kolmogorov-Smirnov and Shapiro-

Wilk's tests. Additionally, to test the assumption of sphericity, Mauchly's test was applied to demonstrate that variance of the differences between levels of within-participants factors is equal across all the groups in the population.

A number of statistical analyses were done by regarding to the research questions of the study, to show the differences between (exercise intensity and experience level) (experience level and stimulus speed), (exercise intensity and stimulus speed) and of the participants in coincidence anticipation timing accuracy and consistency at different conditions (Rest, moderate, & high), stimulus speeds (1, 3, & 5) and experience level (sedentary, beginner & experienced). These scores were separately analyzed by conducting Mixed model ANOVA. In the coming tables, schematic depictions of the statistical analysis design are shown as Tables 3.2, 3.3, & 3.4.

Table 3.2 Statistical Design for Exercise Intensity × Experience level

Error Measurements	***Experience level***	***Exercise intensity***	***Mean***	***SD***
Error Measurement	novice	Rest		
		Moderate		
		High		
	sedentary	Rest		
	experienced	Rest		
		Moderate		
		High		

Exercise intensities (Rest, moderate & high) and stimulus speeds (1, 3, & 5 mph) were the within-participant factors and. On the other hand, the between-participant factor was experience level (novice, sedentary, & experienced). It should be mentioned that experience level (sedentary, novice, & experienced), exercise intensity (Rest, 70%, & 90% HRR), & stimulus speeds (1, 3, & 5) were independent

variables, while CAT and consistency (|CE| & VE) were the dependent variables of this study.

Table 3.3 Statistical Design for Stimulus Speed × experience level

Error Measurement	***Experience level***	***Stimulus Speed***	***Mean***	***SD***
Error Measurement	sedentary	1 mph		
		3mph		
		5 mph		
	novice	1 mph		
		3mph		
		5 mph		
	experienced	1 mph		
		3mph		
		5 mph		

By regarding the research questions of the presented study in terms of investigating the influence of different exercise intensities & different stimulus speeds on CAT, both variables were within-participants factors. Accordingly, Mixed model ANOVA was applied.

Table 3.4 Statistical Design for Exercise Intensity × Stimulus Speed

Error Measurements	***Exercise Intensity***	***Stimulus Speed***	***Mean***	***SD***
Error Measurement	Rest	1 mph		
		3mph		
		5 mph		
	70%	1 mph		
		3 mph		
		5 mph		
	90%	1 mph		
		3 mph		
		5 mph		

CHAPTER 4

RESULTS

The following chapter represented the needed data with respect to the outcomes of the study by dividing it into four different parts. In the first part, the effects of different stimulus speeds (1, 3, & 5) on coincidence anticipation timing will be explained by regarding different levels of stimulus speeds and badminton players versus sedentary. In the second part, the effects of different Stimulus Speed (1, 3, & 5) on coincidence anticipation timing performance will be enlightened in connection with stimulus speed and experienced, novice versus sedentary. In the third section, the effect of different levels of exercise intensity (70%) on coincidence anticipation timing will be presented with respect to 70 % exercise intensity and experienced-novice. Finally, the effects of exercise intensity (90%) on coincidence anticipation timing will be presented with respect to 90 % exercise intensity and experienced-novice. dependent variables were an absolute error (accuracy) and variable error (consistency), raw scores were explained as mean & standard deviation for all analysis. The needed descriptive analyses and related assumption tests were completed and concisely clarified in six sub-sections.

4.1. Stimulus Speed (1, 3, & 5) and Experience Level (Experienced, novice, & sedentary) in Rest Condition

Variable Error (VE): Mixed model ANOVA was completed to check if coincidence anticipation timing consistency (VE) varied between different experience levels (experienced, novice, & sedentary) within three different stimulus speeds (1, 3, & 5 mph) at rest condition. Prior to the main analysis, the needed assumptions

(homogeneity normality, & sphericity) of variable errors were tested. Descriptive results of stimulus speed and badminton players versus sedentary differences on variable error were demonstrated in Table 4.1.

Table 4.1. Descriptive Results of Stimulus Speed and Experience Level of Participant Differences on VE at Rest

	Group	***M***	***SD***	***N***
Rest_1	novice	89.37	31.33	43
	experienced	74.03	21.5	42
	sedentary	100.87	28.92	54
	Total	89.59	29.83	139
Rest_3	novice	92.76	31.65	43
	experienced	78.38	28.81	42
	sedentary	100.19	23.68	54
	Total	91.30	29.14	139
Rest_5	novice	84.23	31.87	43
	experienced	75.40	24.44	42
	sedentary	87.58	25.02	54
	Total	82.87	27.45	139

Interaction Effect (VE): Mixed model ANOVA results showed that there was no interaction among experienced, novice and sedentary participants at different level of stimulus speeds (1, 3, & 5 mph) on CAT performance for variable error ($F(2,270) = 1.46$, $p > .05$), Indicating that the consistency of CAT scores were not changed significantly among different experience level across 1, 3, & 5 mph stimulus speeds at rest situation (Table 4.2, and Figure 4.1).

Table 4.2. Multivariate Results of Stimulus Speed and Experience Level on VE

	F	***Error df***	***Sig***	**η2**
Wilks L	1.46	270.00	.22	.02

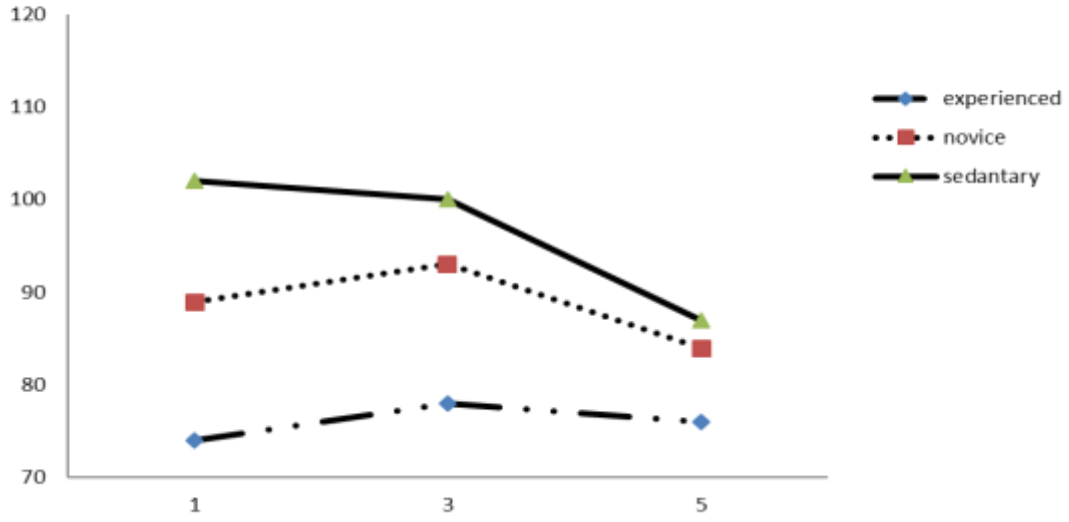

Figure 4.1. Interaction graph for experienced, novice and sedentary on VE at Rest

Main Effects (Within Subject-Effects): According to within-subject results, there was a significant difference among experienced, novice and sedentary participants at a different level of stimulus speeds on CAT in rest state (F (2, 272) =4.43, η2=.01, p<.05). (Table 4.3)

Table 4.3. Within Subject Results of Stimulus Speed and Experience Level on VE

	df	***MS***	***F***	**Sig**	**η2**
Rest_VE	2	2399.16	4.43	.01	.03

Between Subject Effects: The outcomes stated that there were significant differences among experienced, novice and sedentary participants at three different levels of stimulus speeds on CAT in rest situations (F (2,136) =12.6, η2=.16, p<.05) (Shown in Table 4.4), While the between-subject results effect was detected, a follow-up test for determining the reason for the effect was checked. The results indicated that experienced badminton players performed better than novice

badminton players and sedentary participants (p<.05). Outcomes also indicated that there was no difference between novice badminton player and sedentary participants (p>.05). (Table 4.5)

Table 4.4. Between Subject Results of stimulus speed and Experienced, Novice, and sedentary Differences on VE

	df	***MS***	***F***	***Sig.***	η^2
Group	2	15121.54	12.6	**.00**	.16
Error	136	1200.18			

Table 4.5. Table of Bonferonni Follow-Up Test

(I) Group	**(J) Group**	**Mean Difference (I-J)**	**Std. Error**	**Sig.**
novice	experienced	12.85	4.34	.01
	sedentary	-7.76	4.09	.18
experienced	novice	-12.85	4.34	.01
	sedentary	-20.61	4.12	.00
sedentary	novice	7.76	4.09	.18
	experienced	20.61	4.12	.00

Absolute Error (|AE|): Mixed model ANOVA was performed to check if coincidence anticipation timing accuracy varied among sport participation at three different stimulus speeds (1, 3, & 5 mph) at-rest state. The needed assumptions of normality and homogeneity were checked. Descriptive results of stimulus speed and experienced, novice and sedentary differences on absolute error were shown in Table 4.6.

Table 4.6. Descriptive Results of Stimulus Speed and Experienced, Novice and Sedentary Differences on AE

	Group	***n***	***M***	***SD***
Rest_1	novice	43	152.05	62.61
	experienced	42	143.14	63.94
	sedentary	54	150.98	58.33
	Total	139	148.95	61.06
Rest_3	novice	43	102.77	47.07
	experienced	42	88.70	36.29
	sedentary	54	103.21	41.48
	Total	139	98.69	42.07
Rest_5	novice	43	86.33	41.13
	experienced	42	80.48	30.61
	sedentary	54	89.50	38.09
	Total	139	85.79	36.94

Interaction Effect: Mixed model ANOVA results of |AE| revealed that there was no interaction among experienced, novice and sedentary participants at different stimulus speeds on CAT in rest condition for absolute error ($F(2,270) = .23$, $p > .05$), which indicating that the accuracy of coincidence anticipation timing scores were not changed significantly among experienced, novice and sedentary participants at different stimulus at rest condition. (See Table 4.7 & Figure 4.2).

Table 4.7. Multivariate Results of Stimulus Speed and Experienced, Novice and Sedentary Differences on AE

	F	***Error df***	***Sig***	**η2**
Wilks L	.23	270.00	.92	.00

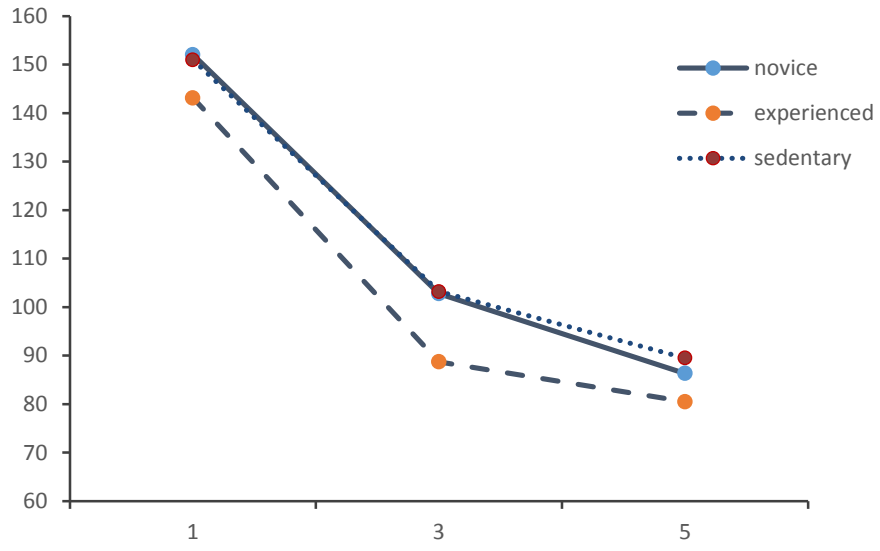

Figure 4.2. Interaction graph for the group by speed on AE at rest condition

Main Effects (Within Subject Effect): According to within-subject results, there was a significant difference among experienced, novice and sedentary participants at different stimulus speeds in rest condition (F (2, 272) =105.09, η2=.44, p<.05). (See Table 4.8)

Table 4.8 within Subject Results of Stimulus Speed and Experienced, Novice, and Sedentary Differences on AE

	df	***MS***	***F***	***Sig.***	η^2
Rest_AE	2	153692.1	105.09	**.00**	.44
Error (Rest_AE)	272	1462.55			

Main Effects (Between Subject Effects): According to between-subject results, there was no significant difference among experienced, novice and sedentary participants at different stimulus speeds in rest condition (F (2,136) =1.13, p> .05). (See Table 4.9)

Table 4.9. Between Subject Results of Stimulus Speed and Experienced, Novice and Sedentary Differences on AE

	df	***MS***	***F***	***Sig.***	***η2***
Group	2	4493.49	1.13	.33	.02
Error	136	3965.57			

B) With respect to rest and stimulus speed (variable error): ANOVA outcomes presented that there was a significant difference between rest and stimulus speed on CAT performances of sedentary (F (2,128) =3.81, p<.05). No significant difference was found in the badminton group (p>.05). (Table 4.10)

Table 4.10. ANOVA Results of Rest and Stimulus Speed on VE

		df	***Mean Square***	***F***	***Sig.***
Badminton	Between Groups	2	295.92	.29	.75
	Within Groups	126	1007.60		
Sedentary	Between Groups	2	2720.68	3.81	.03
	Within Groups	126	713.27		

Also, the results showed that the sedentary group performed better CAT on 1 m/s stimulus speed than 3 & 5 m/s stimulus speeds. (Table 4.11)

Table 4.11. Bonferonni Follow-up Test Results of Rest and Experienced-Novice Differences on VE

Dependent Variable	***(I) group***	***(J) group***	***Mean Difference (I-J)***	***SE***	***Sig.***
Badminton	1 m/s	3 m/s	-1.53	6.73	1.00
		5 m/s	3.63	6.97	1.00
	3 m/s	1 m/s	1.53	6.73	1.00
		5 m/s	5.16	6.86	1.00
	5 m/s	1 m/s	-3.63	6.97	1.00
		3 m/s	-5.16	6.86	1.00
sedentary	1 m/s	3 m/s	8.93	5.67	.35
		5 m/s	16.15	5.87	**.02**
	3 m/s	1 m/s	-8.93	5.67	.35
		5 m/s	7.22	5.77	.64
	5 m/s	1 m/s	-1.15	5.87	**.02**
		3 m/s	-7.22	5.77	.64

With respect to rest condition and stimulus speed (absolute error): Outcomes indicated that there was a significant difference between rest and stimulus speed on CAT performances of sedentary (F (2,128) =36.34, p<.05) and badminton groups (F (2,128) = 31.88, p<.05). (Table4.12)

Table 4.12. ANOVA Results of Rest and Stimulus Speed on AE

		df	***Mean Square***	***F***	***Sig.***
Badminton	Between Groups	2	69982.90	31.88	.00
	Within Groups	126	2195.52		
Sedentary	Between Groups	2	86696.06	36.34	.00
	Within Groups	126	2385.60		

Also, the results indicated that badminton players group performed better on 1 m/s stimulus speed than 3 m/s and 5 m/s stimulus speeds. On the sedentary group, 1 m/s stimulus speed was performed better than 3 m/s & 5 m/s. (Table4.13)

Table 4.13. Bonferonni Follow-up Test Results of Rest and Experienced-Novice Differences on AE

Dependent Variable	***(I) group***	***(J) group***	***Mean Difference (I-J)***	***Std. Error***	***Sig.***
Badminton	speed 1	speed 3	49.43	7.95	.00
		speed 5	58.77	7.89	.00
	speed 3	speed 1	-49.43	7.95	.00
		speed 5	9.34	7.92	.72
	speed 5	speed 1	-58.77	7.89	.00
		speed 3	-9.34	7.92	.72
Sedentary	speed 1	speed 3	50.10	8.29	.00
		speed 5	67.69	8.23	.00
	speed 3	speed 1	-50.10	8.29	.00
		speed 5	17.59	8.26	.10
	speed 5	speed 1	-67.69	8.23	.00
		speed 3	-17.59	8.26	.10

4.2. Exercise Intensity (70%) & Experience Level (experienced, novice)

A) With respect to 70 % exercise intensity and experienced-novice (VE):

a) There is no interaction between exercise intensity and experienced-novice on CAT.

b) Exercise intensity and experienced-novice do not have significant effects on CAT in badminton participants.

Variable Error (VE): Mixed model ANOVA was applied to check whether the variability of coincidence anticipation timing differed between sport participation (experienced & novice) across three stimulus speeds at 70% exercise intensity. Demographical results of exercise intensity and sport participation were shown in Table 4.14 and Figure 4.3.

Table 4.14 Descriptive Results of Exercise Intensity (70 %) and Experienced-Novice Differences on VE

	Group	***N***	***M***	***SD***
Seventy_1	novice	43	100.58	33.68
	experienced	42	91.59	35.96
	Total	85	96.14	34.91
Seventy_3	novice	43	85.82	31.52
	experienced	42	80.87	28.58
	Total	85	83.38	30.02
Seventy_5	novice	43	73.98	23.71
	experienced	42	71.46	27.69
	Total	85	72.73	25.63

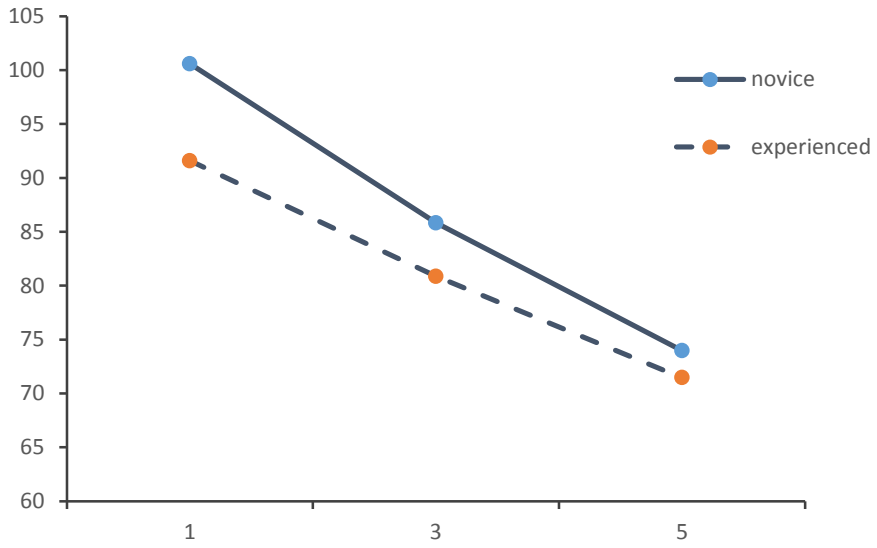

Figure 4.3. Descriptive results of both groups on VE

Interaction Effect: Mixed model ANOVA results of VE presented that there was no interaction between exercise intensity & experience level of participants at different stimulus speeds on CAT for variable error ($F(2, 82) = .33$, $\eta 2 = .01$, $p > .05$) which indicating that the consistency of coincidence anticipation timing scores were

not changed significantly between exercise intensity & experience level of participants at different stimulus speeds. (Table 4.15)

Table 4.15 Multivariate Results of Exercise Intensity (70 %) and Experienced-Novice Differences on VE

	F	***Error df***	***Sig***	**η2**
Wilks L	.33	82.00	.72	.01

Main Effects (Within-Subjects Effects): According to within-subject results, there were significant differences between exercise intensity of both groups in 70 % exercise intensity (F (2, 166) =16.53, η2=.17, p<.05) which was shown in Table 4.16.

Table 4.16. Within Subject Results of Stimulus Speed and Experience Level on VE

	df	***MS***	***F***	**Sig**	**η2**
70%_VE	2	23262.26	16.53	.00	.17

Main Effects (Between Subject Effects): The results of between-subjects showed that there was no significant difference between experienced & novice badminton players (F (1, 83) =1.40, η2=.02, p> .05). (See Table 4.17)

Table 4.17 between Subject Results of Exercise Intensity (70 %) and Experienced-Novice Differences on VE

	df	***Mean Square***	***F***	***Sig.***	η^2
Group	1	1917.62	1.40	.24	.02
Error	83	1374.69			

B) With respect to Stimulus speed & exercise intensity (variable error):

a) There is no difference between the three stimulus speeds (1m/s, 3m/s, 5m/s) in terms of 70 % on CAT.

b) Exercise intensity and stimulus speed do not have significant effects on CAT in badminton participants.

Variable Error (VE): ANOVA was applied to check whether the variability of coincidence anticipation timing varied among stimulus speed (1m/s, 3m/s, 5m/s) across at 70% exercise intensity. ANOVA results showed that there was a significant difference between exercise intensity and stimulus speed on CAT performances of sedentary ($F(2,125) = 11.03$, $p<.05$) and badminton groups ($F(2,125) = 4.76$, $p<.05$). (See Table 4.18)

Table 4.1 8 ANOVA Results of Exercise Intensity (70 %) and Stimulus Speed on VE

		df	***Mean Square***	***F***	***Sig.***
Sedentary	Between Groups	2	8732.11	11.03	.00
	Within Groups	123	791.66		
Badminton	Between Groups	2	3209.75	4.76	.01
	Within Groups	123	674.06		

Table 4.19 indicates that badminton players group performed better on 1 m/s stimulus speed than 5 m/s stimulus speeds. On the other hand, a sedentary group, 1 m/s stimulus speed was performed better than 5 m/s.

Table 4.1 9 Bonferonni Follow-up Test Results of Exercise Intensity (70 %) and Experienced-Novice Differences on VE

Dependent Variable	***(I) Group***	***(J) Group***	***Mean Difference (I-J)***	***SE***	***Sig.***
Sedentary	1 m/s	3 m/s	14,60228	6,07	.05
		5 m/s	29,02123*	6,18	.00
	3 m/s	1 m/s	-14,60228	6,07	.05
		5 m/s	14,41895	6,18	.06
	5 m/s	1 m/s	-29,02123*	6,18	.00
		3 m/s	-14,41895	6,18	.06
Badminton	1 m/s	3 m/s	10,77345	5.60	.17
		5 m/s	17,37547*	5.70	.01
	3 m/s	1 m/s	-10,77345	5.60	.17
		5 m/s	6,60202	5.70	.75
	5 m/s	1 m/s	-17,37547*	5.70	.01
		3 m/s	-6,60202	5,70326	.75

C) With respect to 70 % exercise intensity and experienced-novice (AE):

Demographic results of 70 % exercise intensity and experienced-novice differences were demonstrated in Table 4.20.

Table 4.20 Descriptive Results of Exercise Intensity (70 %) and Expert-Novice Differences on AE

	Group	***M***	***SD***	***N***
Seventy_1	novice	148.52	53.67	43
	experienced	134.96	47.12	42
	Total	141.82	50.70	85
Seventy_3	novice	87.60	38.24	43
	experienced	82.94	28.02	42
	Total	85.30	33.46	85
Seventy_5	novice	78.99	37.18	43
	experienced	77.53	33.49	42
	Total	78.27	35.20	85

Mixed model ANOVA results showed that there was no interaction between exercise intensity & experienced-novice on CAT performance (F (2,82) =.79, p>.05). (Table 4.21)

Table 4.21 Multivariate Results of Exercise Intensity (70 %) and Experienced-Novice Differences on AE

	F	***Error df***	***Sig***	**η2**
Wilks L	.79	82.00	.46	.02

Main Effects (Within-Subjects Effects): According to within-subject results, there were significant differences among exercise intensity of both groups (F (2, 166) =113.34, η2=.58, p<.05). (Table 4.22)

Table 4.22 within Subject Results of Exercise Intensity (70 %) and Experienced-Novice Differences on AE

	df	***Mean Square***	***F***	***Sig.***	η^2
70%_AE	2	102959.22	113.34	.00	.58
Error	166	908.44			

Main Effects (Between Subject Effects): According to the main effect results, there was no significant difference between experienced and novice badminton players (F (1, 83) = .88, p>.05). (Table 4.23, Figure 4.4)

Table 4.23 between Subject Results of Exercise Intensity (70 %) and Experienced-Novice Differences on AE

	df	***MS***	***F***	***Sig.***	η^2
Group	1	2741.96	.88	.35	.01
Error	83	3118.93			

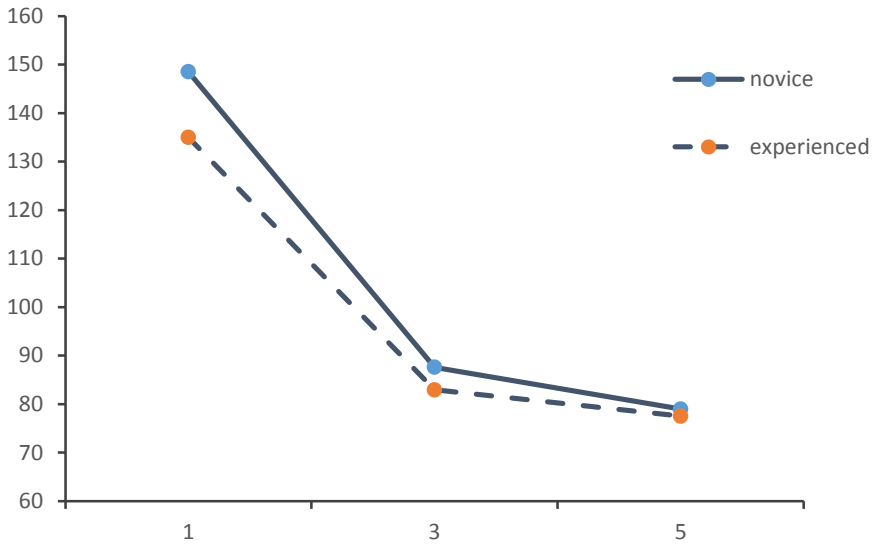

Figure 4.4. Interaction graph for Badminton players on AE at 70%

D) With respect to stimulus speed & experienced-novice (AE):

ANOVA results of 70 % exercise intensity and stimulus speed differences were demonstrated in Table 4.24. ANOVA results showed that there was a significant difference between exercise intensity and stimulus speed on CAT performances of sedentary (F (2,125) =28.54, p<.05) & badminton groups (F (2,125) =31.22, p<.05).

Table 4.24 ANOVA Results of Exercise Intensity (70 %) and Stimulus Speed on AE

		df	***Mean Square***	***F***	***Sig.***
Badminton	Between Groups	2	40206.67	28.54	.00
	Within Groups	123	1408.83		
Sedentary	Between Groups	2	60811.66	31.22	.00
	Within Groups	123	1947.94		

Table 4.25 indicates that badminton players group performed better on 1 m/s stimulus speed than 3 m/s and 5 m/s stimulus speeds. On the sedentary group, 1 m/s stimulus speed was performed better than 3 m/s and 5 m/s.

Table 4.25 Bonferonni Follow-up Test Results of Exercise Intensity (70 %) and Experienced-Novice Differences on AE

Dependent Variable	***(I) Group***	***(J) Group***	***Mean Difference (I-J)***	***SE***	***Sig.***
badminton	1 m/s	3 m/s	51.06	8.09	.00
		5 m/s	55.40	8.25	.00
	3 m/s	1 m/s	-51.06	8.09	.00
		5 m/s	4.33	8.25	1.00
	5 m/s	1 m/s	-55.40	8.25	.00
		3 m/s	-4.33	8.25	1.00
sedentary	1 m/s	3 m/s	60.92	9.52	.00
		5 m/s	69.60	9.70	.00
	3 m/s	1 m/s	-60.92	9.52	.00
		5 m/s	8.68	9.70	1.00
	5 m/s	1 m/s	-69.60	9.70	.00
		3 m/s	-8.68	9.70	1.00

4.3. Exercise Intensity (90%) & Experience Level (experienced, novice)

A) With respect to 90 % exercise intensity & experience level (experienced-novice):

a) There is no interaction between exercise intensity (90%) & experienced-novice on CAT.

b) Exercise intensity and experienced-novice do not have significant effects on CAT in badminton participants.

Variable Error (VE): Mixed model ANOVA was applied to check whether the variability of coincidence anticipation timing varied between experience level (experienced & novice) across three stimulus speeds at 90% exercise intensity. Demographical results of exercise intensity and experience level were shown in Table 4.26 & Figure 4.5. Mixed ANOVA results showed that there was no interaction

between exercise intensity (90%) & experienced-novice on CAT performance (F (2, 82) =.54, η2=.01, p>.05).

Table 4.26 Descriptive Results of Exercise Intensity (90 %) and Experienced-Novice Differences on VE

	Group	***N***	***M***	***SD***
ninety_1	novice	43	88.58	39.64
	experienced	42	86.79	28.92
	Total	85	87.70	34.56
ninety_3	novice	43	92.62	34.53
	experienced	42	87.64	27.63
	Total	85	90.16	31.22
ninety_5	novice	43	76.39	25.23
	experienced	42	66.16	20.60
	Total	85	71.33	23.49

Table 4.27 Interaction Effects of Exercise Intensity (90 %) and Experienced-Novice Differences on VE

F	***Error df***	***Sig***	**η2**
Wilks L 15.61	82.00	.54	.01

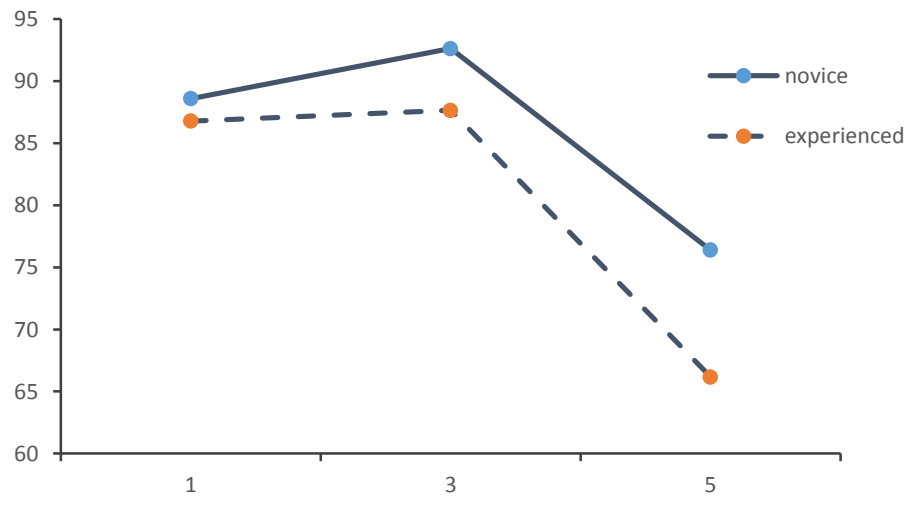

Figure 4.5. Interaction graph for badminton players on VE at 70%

Main Effects (within-subjects): According to within-subject results, there were significant differences among stimulus speeds of both groups (F (2, 166) =12.85, η2=.13, p<.05). (See Table 4.28)

Table 4.28 within Subject Effects of Exercise Intensity (90 %) and Experienced-Novice Differences on VE

	df	***MS***	***F***	***Sig.***	η^2
90%_VE	2	8936.63	12.85	.00	.13
Error	166	695.58			

Main Effects (between subjects): The results of between-subjects showed that there was no significant difference between experienced and novice badminton players (F (1, 83) =1.54, p> .05). (See Table 4.29)

Table 4.29 between Subject Results of Exercise Intensity (90 %) and Experienced-Novice Differences on V E

	df	***Mean Square***	***F***	***Sig.***	η^2
Group	1	2045.76	1.54	.22	.02
Error	83	1329.41			

B) With respect to 90 % exercise intensity and Stimulus speed (1m/s, 3m/s, 5m/s) on variable error:

a) There is no difference between the three stimulus speeds (1m/s, 3m/s, 5m/s) in terms of 90 % exercise intensity on CAT.

b) Exercise intensity and stimulus speed do not have significant effects on CAT in badminton participants.

ANOVA results showed that there was a significant difference between exercise intensity & stimulus speed on CAT performances of the badminton group (F (2,125) =8.94, p<.05). The non-significant difference was found for the sedentary group (p>.05). (Table 4.30)

Table 4.30 ANOVA Results of Exercise Intensity (90 %) and Stimulus Speed on VE

		df	***Mean Square***	***F***	***Sig.***
Badminton	Between Groups	2	6058.60	8.94	.00
	Within Groups	123	678.11		
	Total	125			
Sedentary	Between Groups	2	2968.27	2.57	.08
	Within Groups	123	1153.52		
	Total	125			

Also, the results indicated that badminton players group performed better on 1 m/s stimulus speed than 5 m/s stimulus speeds. They also performed better on 3m/s and 1 m/s stimulus speeds than 5 m/s stimulus speed. (Table 4.31)

Table 4.31 Bonferonni Follow-up Test Results of Exercise Intensity (90 %) and Experienced-Novice Differences on V E

Dependent Variable	***(I) Group***	***(J) Group***	***Mean Difference (I-J)***	***SE***	***Sig.***
Sedentary	1 m/s	3 m/s	-4.97	7.41	1.00
		5 m/s	11.43	7.41	.38
	3 m/s	1 m/s	4.97	7.41	1.00
		5 m/s	16.39	7.41	.09
	5 m/s	1 m/s	-11.42	7.41	.38
		3 m/s	-16.39	7.41	.09
Badminton	1 m/s	3 m/s	.25	5.68	1.00
		5 m/s	20.93	5.68	.00
	3 m/s	1 m/s	-.25	5.68	1.00
		5 m/s	20.68	5.68	.00
	5 m/s	1 m/s	-20.93	5.68	.00
		3 m/s	-20.68	5,68	.00

C) With respect to 90 % exercise intensity & experienced-novice (AE):

Absolute error demographic results of 90 % exercise intensity & experienced-novice differences were demonstrated in Table 4.32.

Table 4.32 Descriptive Results of Exercise Intensity (90 %) and Experienced-Novice Differences on AE

	Group	***N***	***M***	***SD***
ninety_1	novice	43	137.77	44.81
	experienced	42	142.34	62.47
	Total	85	140.03	53.98
ninety_3	novice	43	95.87	44.15
	experienced	42	92.44	36.12
	Total	85	64.17	40.18
ninety_5	novice	43	80.59	34.97
	experienced	42	80.06	42.34
	Total	85	80.33	38.56

Mixed model ANOVA results showed that there was no interaction between exercise intensity & experienced-novice on CAT performance ($F (2, 82) =.22$, $\eta 2=.01$, $p>.05$) (Table 4.33 & Figure 4.6)

Table 4.33 Interaction Effects of Exercise Intensity (90 %) and Experienced-Novice Differences on AE

		F	***Hypothesis df***	***Error df***	***Sig.***	η^2
Ninety AE	Pillai's Trace	60.79	2.00	82.00	.00	.6
	Wilks' Lambda	60.79	2.00	82.00	.00	.6
	Hotelling's Trace	60.79	2.00	82.00	.00	.6
	Roy's Largest Root	60.79	2.00	82.00	.00	.6
Ninety* group	Pillai's Trace	.22	2.00	82.00	.8	.01
	Wilks' Lambda	.22	2.00	82.00	.8	.01
	Hotelling's Trace	.22	2.00	82.00	.8	.01
	Roy's Largest Root	.22	2.00	82.00	.8	.01

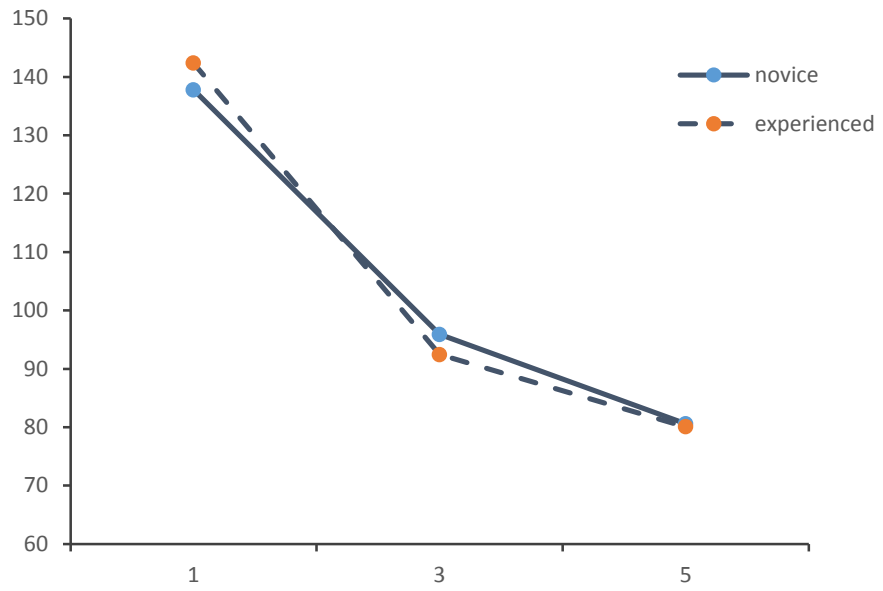

Figure 4.6. Interaction graph for badminton players on AE at 90%

Main Effects (within-subjects): The results showed that there were significant differences among stimulus speeds of both groups (F (2, 166) = 72.45, η2=.47, p<.05). (Table 4.34)

Table 4.34 Within Subject Effects of Exercise Intensity (90 %) and Experienced-Novice Differences on AE

	df	***MS***	***F***	***Sig.***	η^2
90%_AE	2	83097.98	72.45	.00	.47
Error	166	1147.02			

Main Effects (between-subjects): According to the main effect results (between subjects), there was no significant difference between experienced and novice badminton players (F (1, 83) =.00, η2=.00, p>.05). (Table 4.35)

Table 4.35 Between Subject Results of Exercise Intensity (90 %) and Experienced-Novice Differences on AE

	df	***MS***	***F***	***Sig.***	η^2
Group	1	2.61	.00	.98	.00
Error	83	3785.59			

D) With respect to stimulus speed & experienced-novice (AE):

ANOVA results showed that there was no significant difference between exercise intensity and stimulus speed on CAT performances of badminton group (p>.05) & sedentary group (p>.05). (Table 4.36)

Table 4.36 ANOVA Results of Exercise Intensity (90 %) and Stimulus Speed on AE

		df	***Mean Square***	***F***	***Sig.***
Sedentary	Between Groups	2	2480.23	2.61	.08
	Within Groups	123	950.38		
	Total	125			
Badminton	Between Groups	2	954.84	1.30	.28
	Within Groups	123	737.43		
	Total	125			

CHAPTER 5

DISCUSSION

The presented study was essentially conducted to evaluate how different exercise intensities (Rest, 70%, & 90%) & different stimulus speeds (1, 3, & 5) affect the performance of badminton players (novice and experienced) and sedentary ones with respect to coincidence anticipation timing performance age ranges from 11 to 17. In this respect, the effect of experience level on coincidence anticipation timing was tested once with different exercise intensities at different stimulus speeds. Furthermore, CAT performance was evaluated without looking for participants' gender. In this part, the mentioned research questions will be independently argued by considering the mentioned research hypotheses as well as the outcomes in line with the recent literature.

5.1. Stimulus Speed (1, 3, & 5) and Experience Level (Experienced, novice, & sedentary) in Rest Condition

For the study of the effects of stimulus speed (1, 3, & 5) and experience level on coincidence anticipation timing at rest condition, the coming null hypotheses were expressed in the existing study; a) There is no interaction between Stimulus speed and experienced-novice versus sedentary on CAT; b) Stimulus speed and experienced-novice versus sedentary do not have significant effects on CAT in badminton participation. It should be added that the mentioned hypotheses were evaluated on both variable and absolute errors.

A) Variable Error (VE): Mixed model ANOVA was conducted to test whether the variability of coincidence anticipation timing differed among sport participation across three stimulus speeds at rest condition with respect to stimulus speed and experienced, novice versus sedentary. By regarding the consistency of coincidence anticipation timing scores, the results showed that there was no interaction between badminton players and sedentary at different stimulus speeds on CAT performance for variable error in rest condition. It means that the consistency of coincidence anticipation timing scores did not significantly vary between experienced-novice and sedentary within three different stimulus speeds at rest conditions. The within-subject results also showed that there was a significant difference in stimulus speeds for all groups. On the other hand, the results of between-subjects were indicated that there were significant differences between badminton players and sedentary participants for variable error, demonstrating that badminton players performed significantly better than sedentary participants. The follow-up analysis indicated that experienced badminton players had significantly less variable error than novice badminton players and sedentary participants. Results also showed that there was no difference between novice badminton player and sedentary participants.

Lyons et al. (2013) studied the effects of moderate and high-intensity fatigue on groundstroke in both non-expert and professional tennis players (17 non-experts, & 13 experienced). Mixed model ANOVA's results showed significant fatigue effects (Loughborough Intermittent Tennis Test with moderate (70%) and high-intensities (90%) on groundstroke accuracy regardless of proficiency level. The experienced participants, however, kept better groundstroke accuracy across all situations matched to the novice participants. Also, Groundstroke accuracy under moderate levels of fatigue was equal to that at rest condition which supported the findings of the presented study. Williams et al. (1994) studied Skill-based variances in anticipation of tactics within open-play conditions in soccer players (Experienced

and non-experienced). The results showed that experienced participants showed better anticipatory performance.

By reviewing the literature, it can be seen that a small number of researches studied the effect of different stimulus speeds which may reveal ambiguous outcomes in the performance of coincidence anticipation timing (Williams et al., 2002; Duncan et al., 2013; Duncan et al., 2015). In fact, the timing of the task performed by participants is essential for these equivocal results in the coincidence anticipation timing performance. Even though different stimulus speeds being emphasized as the main feature while investigating the influence of different exercise intensities (Fleury & Bard, 1985). By looking at the recent studies (Sanders, 2011), it has been shown that weak coincidence anticipation performance was associated with higher stimulus speeds at rest mood. Wrisberg et al. (1982) studied the effect of stimulus speed on coincidence anticipation timing task to see the difference between absolute error and variable errors, the outcomes showed that faster stimulus speeds caused lower absolute error and variable and may produce a late response by participants. Williams et al. (2002) conducted a study with respect to the effect of stimulus speed on CAT performance, the results showed that male players were consistent with female ones at low stimulus speed (6 mph) which is in line with the presented study. The authors of this study mentioned that CAT performance seems to be developed by practice and adaptable to deviations in ecological demands. The writers also believed that response timing may possibly be synchronized by the combination of continuous processes of perceptual reactions and motor responses. Lyons et al (2008) conducted a study by involving expert and novice hurler participants and using 5 mph (as a stimulus speed) on basin anticipation timer to see the effects of various exercise intensities on the performance of CAT. The results revealed that experience participants could keep the performance of coincidence anticipation timing performance in all test procedures, while, the novice ones could perform CAT just in 70% exercise intensity (as a moderate

intensity). Also, all participants performed accurate CAT scores at 5 mph stimulus speed supporting the finding of the presented study.

B) Absolute Constant Error (|CE|) (accuracy of coincidence anticipation timing scores): In the case of an absolute error the result of Mixed ANOVA analysis indicated that there was no interaction between stimulus speed and experienced-novice versus sedentary participants at different stimulus speeds on CAT performance in rest condition, which indicates that the accuracy of coincidence anticipation timing scores was not changed significantly among experienced, novice and sedentary participants at different stimulus at rest condition. According to within-subject results, there were significant differences among stimulus speeds of both groups, also, the results of between-subjects showed that there was no significant difference between badminton players and sedentary ones.

The concept of stimulus speed playing an important role in the coincidence anticipation timing performance and has discrepant outcomes (timing of performance). In the study of Meeuwsen, Goode, and Goggin (1995; as cited in Williams et al., 2002, p. 29), the researchers applied a pushing-button to see the participants' performance (stimulus speeds) by using different speeds, and the outcomes showed that variable error reduced significantly by increasing the stimulus speeds.

By studying the literature, it appeared that there were not many types of research with respect to the effects of various stimulus speeds on CAT performance, while, the concept of stimulus speed playing an important role in the coincidence anticipation timing performance and discrepant outcomes (timing of performance). Sanders (2011) and Duncan et al (2015) proposing the fact that poorer CAT performance influenced by increased stimulus speed at rest situation. Duncan et al. (2013) mentioned that intermediate low stimulus speed (1 mph) does not affect the accuracy of coincidence anticipation timing performance scores within different

exercise intensities, but, in 5 mph stimulus speed the accuracy of coincidence anticipation timing performance was better than other speeds, moreover; they believed that high stimulus speed may effects CAT scores negatively.

5.2. Exercise Intensity (70%) & Experience Level (experienced, novice)

For the study of the effect of exercise intensity and sport participation (experienced and novice) on coincidence anticipation timing at 70% exercise intensity condition, the coming null hypotheses were expressed in the existing study; a) There is no interaction between exercise intensity and experienced-novice on CAT.; b) Exercise intensity and experienced-novice do not have significant effects on CAT in badminton participation. It should be added that the mentioned hypotheses were evaluated on variable and absolute error.

A) Variable Error (VE): Mixed model ANOVA was conducted to test whether the variability of coincidence anticipation timing differed between 70% exercise intensity and sport participation, across three stimulus speeds, With respect to exercise intensity and experienced, novice. By regarding to the consistency of coincidence anticipation timing scores, the results showed that there was no interaction between experienced and novice participants at different stimulus speeds on CAT in 70% condition for variable error which indicates that the consistency of coincidence anticipation timing scores was not changed significantly between experienced and novice participants in different stimulus at 70% exercise intensity.

The within-subject results, also showed that there were significant differences among stimulus speeds of both groups in 70 % exercise intensity. On the other hand, the results of between-subjects were indicated that there was no significant difference between experienced and novice badminton players. By regarding the literature review, inconsistent outcomes appeared on the effects of fatigue or

different exercise intensities on CAT performance. Duncan and colleagues (2013) mentioned that the source of these differences is related to the various methods, different sorts of intensities, different sports players, various stimulus speeds, and sport participation background. Lyons et al (2008) conducted a study by involving expert and novice hurler participants and using 5 mph (as a stimulus speed) on basin anticipation timer to see the effects of various exercise intensities on the performance of CAT. The results revealed that experienced participants could keep the performance of coincidence anticipation timing performance in all test procedures, while, the novice ones could perform CAT just in 70% exercise intensity (as a moderate intensity). Al-Nakeeb & Lyons (2007) stated that CAT performance does not change under different exercise intensities, supporting the findings of these studies (Bard & Fleury, 1978; Fleury & Bard, 1985, 1987; Fleury, Bard, 1981).

Absolute Error (|AE|) (accuracy of coincidence anticipation timing scores): In the case of an absolute error the result of Mixed ANOVA analysis indicated that showed that there was no interaction between exercise intensity and expert-novice on CAT performance. This indicates that the accuracy of coincidence anticipation timing scores was not changed significantly between experienced and novice participants at different stimulus in 70% exercise intensity condition. According to within-subject results, there were significant differences between stimulus speeds of both groups, also, the results of between-subjects showed there was no significant difference between experienced and novice badminton players in 70% exercise intensity condition.

With respect to the literature review, the absence of stable outcomes and various results with concern to the influence of different exercise intensities on the performance of coincidence anticipation timing has been confounded by applying a wide variety of methods for the effects exercise intensity, inefficient experimental designs, and significant differences in the forms of motor and cognitive tasks used

as well (Aks, 1998). As a result, the performance of participants may have not been evaluated in a really exertion form in some researches regarding the recovery procedure from the prior exercise intensity. Brisswalter et al. (2002) stated that the failure of paying attention to the physical fitness condition of participants by the investigators is one of the most critical and important issues in research studies and may change the results of studies, also motor skills (the whole-body motion) should be evaluated during activities (McMorris and Keen, 1994). On the other hand, Lyons (2011, p. 57) mentioned that "accustomed to the tightly controlled conditions of laboratory research, some scientists may be reluctant to undertake field-based studies of performance in which all the different variables influencing human performance are not easily controlled". With respect to the mentioned studies, it can be seen that there are limitations and deficiencies in the literature by regrading to the effects of exercise intensity on the performance of participants which showed different outcomes according to the types and methods applied in studies. Duncan et al. (2013) conducted a study by regarding to the effects of stimulus speed and exercise intensity on CAT scores by using treadmill, and the outcomes showed that increased exercise intensity effects CAT performance negatively (in the 3 & 5 mph stimulus speeds), also in 70% exercise intensity the accuracy of participants performances were getting better (5 mph). On the other hand, the results mentioned that there were no significant differences in the performance of participants within different exercise intensities (at low stimulus speed). The final results mentioned that training at a high level of exercise intensity and fast form of stimulus speeds affected the coincidence anticipation timing score negatively.

5.3. Exercise Intensity (90%) & Experience Level (experienced, novice)

For the study of the effect of exercise intensity and sport participation (experienced and novice) on coincidence anticipation timing at 90% exercise intensity condition, the coming null hypotheses were expressed in the existing study; a) There is no

interaction between exercise intensity and expert-novice on CAT.; b) Exercise intensity and experienced-novice do not have significant effects on CAT in badminton participation. It should be added that the mentioned hypotheses were evaluated on variable and absolute error.

A) Variable Error (VE): Mixed model ANOVA was conducted to test whether the variability of coincidence anticipation timing differed between 90% exercise intensity and sport participation, across three stimulus speeds, With respect to exercise intensity and experienced novice background. By regarding to the consistency of coincidence anticipation timing scores, the results showed there was no interaction between exercise intensity (90%) and experienced-novice on CAT performance in 90% condition for variable error which indicates that the consistency of coincidence anticipation timing scores was not changed significantly between experienced and novice participants in different stimulus at 90% exercise intensity.

The within-subject results also showed that there were significant differences among stimulus speeds of both groups in 90 % exercise intensity. On the other hand, the results of between-subjects were indicated that there was no significant difference between experienced and novice badminton players.

In terms of investigating the effect of exercise intensity, Sibley, Etnier, and Le Masurier (2006) used the Stroop colour-word test for the performance of participants and the outcomes showed that walking at moderate intensity and twenty minutes running improves the mentioned tests outcomes. In line with this study, Lyons (2011) evaluated the effect of exercise intensity on a cycle ergometer by using the same test method at three different intensities (rest, 50% heart rate, and 80% heart rate) conditions, in terms of efficiency, the outcomes showed that high level of exercise intensity may the source of weak performance in sport

activities. While the other study showed that there were no significant differences in the performance of the Stroop test through different exercise intensities.

Predicting movements and the speed of moving objects is one of the dominant features in sports, and the sport participants need to have that ability especially the elite ones (Tenenbaum et al., 2000). Al-Nakeeb et al. (2005) conducted a study by considering the effects of exercise intensity on CAT performance, by comparing beginners and experienced players in three different conditions; as follows: a) rest, b) 70% heart rate and c) 90% heart rate on rowing ergometer by basin anticipation timer apparatus. The final results showed that there was no significant difference between low skilled and experienced participants at the mentioned three different exercise intensities in constant and variable errors, which is in line with the results of the presented study. The same investigators conducted follow-up research (in 2007) to see the effects of different exercise intensities (at rest, 50 %, and 80% heart rate) on the CAT task, and the outcomes showed that there are no significant differences between two groups through all conditions. In line with this study Lyons (2011) also mentioned that a high level of exercise intensity does not negatively change the performance of CAT by participants. However, the effect of different exercise intensities on CAT ability may change concerning with the exertion of the task performed.

Absolute Error (|AE|) (accuracy of coincidence anticipation timing scores): In the case of an absolute error the result of Mixed ANOVA analysis indicated that showed that there was no interaction between exercise intensity and expert-novice on CAT performance. Which indicates that the accuracy of coincidence anticipation timing scores was not changed significantly between experienced and novice participants at different stimulus in 90% exercise intensity condition? According to within-subject results, there were significant differences between stimulus speeds of both groups, also, the results of between-subjects showed there was no significant

difference between expert and novice badminton players in 90% exercise intensity condition. In the sports field, the failure of handling efficiently with a high level of effort for players may lead to increasing the threat of injury, reducing concentration; decrease the effectiveness of needed performance, and as a final point failing to win the games (Lyons, 2011). Exercise intensity (Fatigue) is a new area that has attracted researchers, experts, competitors and trainers due to its complicated nature and multifaceted mechanism (Lyons et al., 2013; Duncan et al., 2014).

McMorris (2004) stated that there is a lack of studying the effects of Exhaustion and physical activities impacts, in sports performance. Consequently, there is a need for conducting a wide variety of research in terms of different types of exercise intensity by regrading to the cognitive, motor, and perceptual performance in sport science. Brisswalter, et al (2002) mentioned that the variety of studying techniques may explain why the effects of exertion on cognitive performance are still unclear and the outcomes of studies by using a different experimental design based on various criteria's have shown inconsistent results. For example, some studies applied cycle ergometer (Al-Nakeeb & Lyons, 2007), running on a treadmill (Duncan et al., 2015) and rowing ergometer (Al-Nakeeb et al., 2005). To examine the effects of visual search performance, Aks (1998) conducted a study which comprised of 18 participants by using cycling (as an exercise intensity) in two different conditions: a) bypassing 10 minutes in normal cycling the workload changed into low exercise intensity (65%), b) high (8 minutes at 65% formerly 2 minutes at 85%) by regarding to the accuracy in cognitive performance. Surprisingly, the performance of participants (accuracy) was faster and accurate after exercise on the visual search task. Also, the body has the ability to handle high exercise intensity to keep cognitive performance, which showed that exercise intensity has no effect on the performance of cognitive tasks (Tomporowski, 2003). Other studies mentioned that exercise intensity will improve cognitive performance (Brisswalter et al., 2002) as

well as making the decision in activities (McMorris & Graydon, 1996), supporting that exercise intensity affects the cognitive performance positively. Lyons et al. (2011) studied the effect of high and moderate exercise intensity on sport-skill performance due to the impact of fatigue on sports skills. The mentioned researcher used soccer pass test at rest, 70%, & 100% exercise intensity in their experimental design and the outcomes showed that in the 70% soccer passing skill is better than the rest and 100% exercise intensity conditions, indicating the inverted-U impact on the tested passing performance.

CHAPTER 6

CONCLUSION

The central purpose of this study was to consider the effects of various exercise intensities (rest, 70% HRR as a moderate, & 90% HRR as a high) and different stimulus speeds (1, 3, & 5 mph) on coincidence anticipation timing performance of sedentary, novice, and experienced adolescent badminton players by using Bassin anticipation timer device. In this chapter, an overall discussion concerning the outcomes of the presented study as well as the recommendations will be presented.

The effects of different stimulus speeds (1, 3, & 5 mph) and rest condition (no exercise intensity) were examined among experienced, novice badminton players and sedentary participants. The findings of this study revealed that experienced badminton players were more accurate (performed better) at low stimulus speed (1 mph) than 3 mph and 5 mph stimulus speeds in comparison to novice and sedentary participants in rest condition. It can be mentioned that badminton coaches may enhance their player's performance by involving players at a high level of ball speeds during the training sessions. Moreover, sedentary participants were more accurate at low (1 mph) stimulus speed when there is no comparison to novice and experienced participants. Moreover, experienced badminton players were more consistent than novice badminton players and sedentary participants. While there was no difference between novice badminton players and sedentary participants (in terms of consistency) in rest condition. So, it can be mentioned that increasing the level of experience level improves the player's performance in

badminton which leads to anticipate the speed of the ball precisely and be successful in the area of sports.

On the other hand, the effects of different stimulus speeds (1, 3 & 5 mph) and different exercise intensity (70% heart rate) were examined between experienced and novice badminton players. In terms of accuracy, the findings revealed that there is no significant difference between experienced and novice badminton players in 70% exercise intensity, showing that low exercise intensity does not change the performance of badminton players. Moreover, by comparing the results of badminton players under 70% exercise intensity and sedentary participants under rest conditions, badminton players group were more accurate on 1 m/s stimulus speed than 3 m/s and 5 m/s stimulus speeds than sedentary participants. In terms of consistency, there was no significant difference between experienced and novice badminton players in 70% exercise intensity. The results also showed that badminton players (under 70% exercise intensity condition) were more consistent than sedentary participants (rest condition) at low (1 mph) stimulus speed in comparison with 3 and 5 mph speeds.

The effects of different stimulus speeds (1, 3 & 5 mph) and different exercise intensity (90% heart rate) were examined between experienced and novice badminton players. In terms of accuracy, the findings revealed that there is no significant difference between experienced and novice badminton players in 90% exercise intensity. It can be concluded that high exercise intensity does not change the performance of players and the same results were gained in low exercise intensity as well. In terms of consistency, there was no significant difference between experienced and novice badminton players in 90% exercise intensity. The results also showed that badminton players (under 90% exercise intensity condition) were more consistent than sedentary participants (rest condition) at low (1 mph) stimulus speed in comparison with 3 and 5 mph speeds.

The findings of this study concluded that novice badminton players and sedentary participants had some difficulties anticipating high stimulus speed in rest conditions and high exercise intensity compared to experienced badminton players. So, the outcomes of the presented study offer that badminton trainers should make training sessions of novice players working with each other at high speeds.

6.1. Further Studies

1. (70% HRR) as moderate exercise intensity and (90% HRR) as a high exercise intensity may not reveal the real amount of percentage of fatigue in real badminton games, it can be recommended to apply a test procedure after real badminton training.

2. This study may be applied to different fastball sports such as tennis. Furthermore, it can be tried at various ages to see the changes in further researches.

3. Participants returned to the different stimulus speeds by a racket in a normal standing position which connected to the Bassin anticipation timer device; it can be useful to apply a test in different positions like hitting the ball while running in the test procedure.

4. It can be useful to involve participants in faster stimulus speeds under various exercise intensities to reveal the potential differences between novice and experienced players' performance on CAT performances.

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APPENDICES

A: APPROVAL OF THE METU HUMAN SUBJECTS ETHICS COMMITTEE

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
APPLIED ETHICS RESEARCH CENTER

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
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22 MART 2016

Gönderilen: Doç.Dr. Sadettin KİRAZCI

Beden Eğitimi ve Spor Bölümü

Gönderen: Prof. Dr. Canan SÜMER

İnsan Araştırmaları Komisyonu Başkanı

İlgi: Etik Onayı

Sayın Doç.Dr. Sadettin KİRAZCI'nın danışmanlığını yaptığı doktora öğrencisi Bahman GOLSHAEI'nın "Effects of Different Stimulus Speed and Exercise Intensity on Anticipation Timing by Experience Level in Adolescent Tennis Players" başlıklı araştırması İnsan Araştırmaları Komisyonu tarafından uygun görülerek gerekli onay **2016-EGT-035** protokol numarası ile **28.03.2016-29.05.2016** tarihleri arasında geçerli olmak üzere verilmiştir.

Bilgilerinize saygılarımla sunarım.

Prof. Dr. Canan SÜMER
Uygulamalı Etik Araştırma Merkezi
İnsan Araştırmaları Komisyonu Başkanı

Prof. Dr. Meliha ALTUNIŞIK
İnsan Araştırmaları Komisyonu
Üyesi

Prof. Dr. Ayhan SOL
İnsan Araştırmaları Komisyonu
Üyesi

Prof. Dr. Mehmet UTKU
İnsan Araştırmaları Komisyonu
Üyesi

Yrd.Doç.Dr. Pınar KAYGAN
İnsan Araştırmaları Komisyonu
Üyesi

B: PARENT CONSENT LETTER

1956

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
MIDDLE EAST TECHNICAL UNIVERSITY
06531 ANKARA-TURKEY

Veli Onay Mektubu

Sayın Veliler, Sevgili Anne-Babalar,

Orta Doğu Teknik Üniversitesinde Beden Eğitimi ve Spor Bölümünde doktora öğrencisi olarak "*Farkli Uyari Hizi, Egzersiz Şiddeti ve Deneyim Düzeyinin Genç Badmintonculardaki Zamansal Sezinleme Performansi Üzerindeki Etkileri*" başlıklı doktora tezini yürütmekteyim. Araştırmamın amacı yaşları 11 ve 17 arasında olan kız ve erkek badminton oyuncularının farklı egzersizlerde (dinlenme, orta ve yüksek şiddete) ve farklı uyarı hızlarında (1, 3 & 5 mph) sezinleme zamanlarının farkına bakmaktır. Bu amacı gerçekleştirebilmek için çocuklarınızın testlerimize katılmaları ihtiyaç duyulmaktadır.

Bu çalışma içerisinde zamanı ölçmek için Sezinleme Zamanlayıcısı (Bassin Anticipation Timing); egzersiz şiddetini ayarlayabilmek için koşu bandı ve kalp atımlarını ölçmek için telemetrik Polar saat kullanmaktayız. Oğlunuz/kızınız koşu bandında sub-maksimal düzeyde egzersiz yapacak ve egzersiz sonrası sezinleme zamanları ölçülecektir. Çalışmaya katılım tamimiyle gönüllülük temelindedir. Çocuğunuzun katılmasına izin verdiğiniz takdirde çocuğunuz bir gün içinde Sabah saat 11.00 akşam 5.00 Kadar olçum testleri yapılacaktır. Ulaşım bizim tarafımızdan güvenli bir araçla sağlanacaktır. Test suresi içinde, kimlik belirleyici hiçbir bilgi istenmemektedir. Çocuğunuzun kaydedilen bilgileri kesinlikle gizli tutulacak ve sadece bilimsel araştırma amacıyla kullanılacaktır. Bu formu imzaladıktan sonra hem

siz hem de çocuğunuz katılımcılıktan ayrılma hakkına sahipsiniz. Araştırmayla ilgili sorularınızı aşağıdaki e-posta adresini veya telefon numarasını kullanarak bize yöneltebilirsiniz.

Saygılarımızla,
Bahman Golshaei

Lütfen bu araştırmaya katılmak konusundaki tercihinizi aşağıdaki seçeneklerden size en uygun gelenin altına imzanızı atarak belirtiniz ve bu formu çocuğunuzla okula geri gönderiniz.

A) Bu araştırmaya tamamen gönüllü olarak katılıyorum ve çocuğum .....'nın da katılımcı olmasına izin veriyorum. Çalışmayı istediğim zaman yarıda kesip bırakabileceğimi biliyorum ve verdiğim bilgilerin bilimsel amaçlı olarak kullanılmasını Kabul ediyorum.

Baba Adı-Soyadı	.....	Anne Adı-Soyadı	.....
İmza	.....	İmza	.....

B) Bu çalışmaya katılmayı kabul etmiyorum ve çocuğumun ..... 'nın da katılımcı olmasına izin vermiyorum.

Baba Adı-Soyadı	.....	Anne Adı-Soyadı	.....
İmza	.....	İmza	.....

C: COUNTERBALANCING TABLE

Participants	
Intensity	**Speed**
70%	1 – 5
90%	
90%	1 – 5
70%	
70%	5 – 1
90%	
90%	5 – 1
70%	
70%	1 – 3
90%	
90%	1 – 3
70%	
70%	3 – 1
90%	
90%	3 – 1
70%	
70%	5 – 3
90%	
90%	5 – 3
70%	
70%	3 – 5
90%	
90%	3 – 5
70%	

D: DATA COLLECTION TABLE

Trial	Speed	-/+	Msec		Trial	Speed	-/+	Msec
1					21			
2					22			
3					23			
4					24			
5					25			
6					26			
7					27			
8					28			
9					29			
10					30			
11					31			
12					32			
13					33			
14					34			
15					35			
16					36			
17					37			
18					38			
19					39			
20					40			

E: CALCULATION TABLE

Age	HR_{rest}	HR_{max}	70% HRR	90% HRR
11 (132 months)				
12 (144 months)				
13 (156 months)				
14 (168 months)				
15 (180 months)				
16 (192 months)				
17 (204 months)				

E: CV

Bahman Golshaei

Middle East Technical University, Faculty of Education, Department of Physical Education and Sports

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E-mail: bahmangolshaei@gmail.com

Education:

Ph.D.:

Middle East Technical University, Department of Physical Education and Sport (Ankara/Turkey)

Date of graduation: 2020

Master of Science:

Middle East Technical University, Department of Physical Education and Sport (Ankara/Turkey): 'dynamic and static balance differences based on gender and sport participation'

Date of graduation: 2013

Bachelor's Degree:

Tabriz Azad University, Department of English Language Teaching (Tabriz/Iran)

Date of graduation: 2007

Honors and Awards

Ranked less than top 10 students among state students, having the right to study in English Teaching

Ranked 2 of all Middle East Technical university physical Education and sports Ph.D. students, 2014-2015

Work Experience:

01/2015-2016: Course Assistant in the motor learning field

10/2009-11/2014: METU Baraka Gym

Title: Coach

03/2009 – 07/2009: Yurtkur Fitness Center – Balgat/Ankara

Title: Head Coach

2002 - 2008: Amir Arsalan Fitness center – Salmas/Iran

Title: Coach

2000-2002: Bageri Fitness Center – Salmas/Iran

Title: Coach

Language:

English (fluent in writing, reading, and speaking)

Turkish (fluent in writing, reading, and speaking)

Persian (fluent in writing, reading, and speaking)

Azeri (fluent in writing, reading, and speaking)

Expertise:

-English Language Teaching (Bachelor's Degree)

-Motor Learning (Master’s Degree)

-Motor Learning (Ph.D.)

-Measurement techniques for Static and Dynamic balance tests

- Measurement techniques for Coincidence Anticipation Timing

Research Projects and papers:

"Dynamic and Static Balance Differences Based on Gender and Sport Participation", 2013.

"Effect of Exercise Intensity and Stimulus Speed on Coincidence Anticipation Timing", 2014.

"Comparison of Dynamic balance Differences in Disabled sport participants in three different sports", 2014 – on-going, Hacetteppe University.

"Investigation of the athlete and sedentary visually impaired individuals in terms of anthropometric characteristics", 2015 Hacetteppe University.

Presentations

Golshaei, B. (2016, November). 'The Effect of Different Stimulus Speeds and Different levels Of Badminton Participation on Coincidence Anticipation Timing', 2016 - 14th International Sports Science Congress, Antalya, Turkey.

Golshaei, B. (2016, November) 'Comparison of Static and Dynamic balance between Normal and Hearing-impaired Wrestlers', 2016 – 14th International Sports Science Congress, Antalya, Turkey.

Golshaei, B. (2015, February). 'Static Balance differences with respect to sex and sport participation', 5th International Scientific Conference of IRANIAN Academicians, Ankara, Turkey.

Golshaei, B. (2015, February). 'Gender difference in coincidence Anticipation Timing: effect of exercise intensity and stimulus speed', 5th International Scientific Conference of IRANIAN Academicians, Ankara, Turkey

Golshaei, B. (2013, January). 'Teknoloji ile Bütünleştirilmiş Beden Eğitimi Ve Spor Öğretimi', Hacettepe, Ankara.

Golshaei, B. (2014, November). 'Effects of exercise intensity and stimulus speed on coincidence anticipation timing with respect to gender', Konya, Turkey.

Golshaei, B. (2013, January). 'Teknoloji ile Bütünleştirilmiş Beden Eğitimi Ve Spor Öğretimi', Hacettepe, Ankrara.

Computing:

Adobe Photoshop, Microsoft Word, PowerPoint

Personal interests:

-Developing measurement systems in Coincidence Anticipation Timing.

-Bodybuilding, Dance, Music

- Motor control and Motor Learning, rehabilitation and Sports nutrition.

Activities:

2011-2012: Iran Classic Body Championship – second place, 175 cm category

2008-2009: Ankara Bodybuilding Championship – second place, 65 kg

2005-2006: Power Lifting- organizer

2001-2002: Iran Body Championship – third place, 60 kg

F: TURKISH SUMMARY/TÜRKÇE ÖZET

FARKLI UYARI HIZI, EGZERSİZ ŞİDDETİ & DENEYİM DÜZEYİNİN GENÇ BADMİNTONCULARDAKİ ZAMANSAL SEZİNLEME PERFORMANSI ÜZERİNE ETKİSİ

GİRİŞ

Spor dalında başarılı olabilmek için yüksek seviyede algısal kapasiteye ve ayrıca motor davranışta etkin bir performansa ihtiyaç duyulmaktadır. Üst seviye oyuncular rakip tarafından uygulanan yoğun mekânsal ve geçici kısıtlamalar ile değerlendirilir (Williams, Davids & Williams, 1999). Bu kısıtlamalara göre, bir oyuncunun ilgili bilgiyi kesin ve hızlı bir şekilde algılamasına, karar vermesine, motor davranışını organize etmesine ve hazırlık için daha fazla zaman ayırmasına yardımcı olacaktır (Houlston ve Lowes, 1993; Ripoll, 199). Motor becerilerinin yetkin bir şekilde yerine getirilmesi ile ilgili olarak, özellikle engelleyici hareketler içeren (örneğin, çarpma, vurma ve yakalama) spor türlerinin tamamında yüksek düzeyde algısal beceri ve iyi motor davranış performansı gereklidir (Mori, Ohtani, & Imanaka, 2002; Akpınar, Devrilmez ve Kirazcı, 2012). Raket sporu oyuncularının ve hızlı oynan oyunların büyük çoğunluğunun, yakalanan topu istenen pozisyonuna fırlatmak için doğru zamanda topa vurması gerekir. Aslında, topun rotası vuruşun zamanlamasına ve temas bölgesine bağlıdır. Ayrıca, istenen pozisyonda vuruş yapmak için, erkek ve kadın sporcuların, gelen topun hızını ve yönünü tam olarak tahmin edebilme kabiliyetine sahip olmaları gerekir (Williams, Davids, Burwitz ve Williams, 1994). Sezinleme zamanı (CAT), bireylerin günlük hayatındaki bilişsel performans kavramları arasında yer almaktadır. Örneğin, hızlı tepkiler vermek, aynı zamanda topa vurmak veya yakalamak gibi engelleyici eylemler mükemmel sezinleme yeteneği gerektirir. Bu

nedenle, hareket Eden bir nesnenin zaman ve nihai varış konumunu tahmin etme yeteneği, Sezinleme zamanı yeteneği olarak Kabul edilir (Lyons, Al-Nakeeb ve Nevill, 2008; Sanders, 2011). Sezinleme zamanı, bir nesneyi uzayda ve zamanda hedef bir noktaya ulaşırken tahmin edebilme gücü olarak görülmektedir (Williams, Davids ve Williams, 2000). Sanders (2011), sezinleme zamanı hareket halinde olan bir uyaranın hedefe ne zaman varacağına karar verme yeteneği olarak tanımlanmaktadır. Badminton gibi raket sporlarının çoğunda, gelen topun gelişini önceden tahmin etmek ve topun sahaya doğru çarpması için badminton topunun hareketini takip etmek çok önemlidir. Özellikle doğru vuruş ya da yakalama gerektiren sporlarda, sezinleme tercih edilen bir performansa neden olabilecek önemli bir faktör olarak düşünülebilir (Magill, 2004; Schmidt ve Lee, 2005). Ayrıca, Sezinleme zamanı sporcuları test etmek ve yetenekli bireyleri seçmek için düzenli olarak uygulanmaktadır (Ripoll ve Latiri, 1997). Poulton (1957) aynı zamanda sezinleme zamanı iki çeşit beklentiden oluşmaktadır. Efektör beklentisi (insanların uzuvlarını hareket ettirme sürelerine göre yeteneklerini gösterir) ve reseptör beklentileri (dış etkenlerin bir olayın gerçekleşmesini ne kadar etkilediğini gösterir). McMorris (2004) Sezinlemenin üç bölümünün olduğunu açıklamaktadır: Bir durum sezinlemesi (gerçekleşecek olanlarla ilgili olarak), algısal sezinleme (duruma göre, beklentilerin birinden veya tümünden oluşur); mekânsal sezinleme (duruma bağlı veya bir olayın meydana geleceği yer ile bağlantılı) ve son olarak zaman veya başka bir deyişle bir olayın gerçekleşeceği zaman anlamına gelen geçici sezinlemedir.

Sezinleme zamanın değerlendirilmesi durumunda, son çalışmalardan biri Ak & Koçak (2010), Sezinleme zamanını katılımcının cevap verme kabiliyeti ile yaklaşan şeyin tam hedefe ulaşması arasındaki zaman aralığı ölçümü olduğunu beyan etmiştir. Bu noktada, bu soru ortaya çıkar: Sezinleme zamanı nasıl değerlendirilmelidir? Bu soruyu cevaplamak için Bassin Anticipation Timer (BAT) aparatının bu açıdan yararlı olabileceğini öneren pek çok makaleden bahsedebiliriz (Lyons ve diğerleri, 2008; Akpinar ve diğerleri, 2012; Duncan ve diğerleri, 2013; Kim, Nauhaus)., Glazek, Young

ve Lin, 2013). Akpınar, Devrilmez ve Kirazcı (2012), BAT ’in genel olarak sezinleme zamanın değerlendirilmesinde kullanıldığını belirtmiştir (Magill, Chamberlin ve Hall, 1991; McNevin, Magill ve Buckers, 1994; Williams, vd., 2002; Coker, 2005). Ayrıca Sanders (2011) tarafından yapılan incelemede, bu makineyi 1980'den 2011'e kadar yirmi dokuz makalenin uyguladığı doğrulanmıştır. Ayrıca, farklı egzersiz programlarının spora özgü motorlar üzerindeki etkisini gözlemleyen Abernethy ve Wood (2001) çalışmasında Uygulama sonuçları, BAT ‘in CAT'i doğru değerlendirmesini ve hem kadınlar hem de erkekler için sporda başarılı olmak için uygun bir araç olabileceğini göstermiştir. Aynı zamanda Nettleton ve Smith (1980), BAT ve güvenilirliğinin farklı uyaran hızlarında güvenilirliğini test etmiştir. BAT, makinesinin LED ışıkları (49 lamba) ile ışıkların açılıp kapanmasına neden olan bir kontrolöre bağlanan serinin üç bölümden (2,24 m) oluşur. Ayrıca ışığın yanmasına bağlı olarak tepki vermek için katılımcılar tarafından kullanılacak bir düğme yerleştirilmiştir. Işıkların hızı farklı uyaran hızını göstermektedir (Akpınar, Devrilmez ve Kirazcı, 2012).

Günümüzde, araştırmacılar sezinleme zamanını araştırmak için birçok teknik veya yöntem kullanmışlardır. Bu nedenle, çok sayıda araştırmacı yaş, cinsiyet, yorgunluk etkisi, katılımcıların farklı beceri seviyesi, farklı uyaran hızları (düşük, orta, yüksek) egzersiz yoğunluğu (1,3,5) gibi spor biliminde sezinleme zamanı becerisine ilişkin çeşitli araştırmalar yapmışlardır. Bu bakımdan, Benguigui ve Ripoll (1998), sezinleme zamanı yeteneğinin bazı faktörler ve değişkenler tarafından geliştirilebileceğini veya zayıflayabileceğini açıklamıştır. Ayrıca, katılımcıların yaş faktörü ve spor geçmişinin kombinasyonunun algısal-motor ilerlemelerini etkileyebileceğinden bahsetmişlerdir. Elit sporcular söz konusu olduğunda, birçok faktör bu sporcuları ayırt eder. Bu bağlamda, spor geçmişinin etkisini ve katılımcının hızlı oynamayı gerektiren oyunların (tenis; badminton) yoğun bir uygulaması gibi deneyim düzeyini ele alan çalışmalar, deneyimli oyuncuların sezinleme zamanı konusunda acemilerden daha

başarılı ve tutarlı olduğunu göstermiştir (Bowers ve Stratton, 1993; Brady, 1996; Ripoll ve Latiri, 1997).

Araştırmacılar, uzman katılımcıların üst düzey karar verme, taktik ve teknik yetenekler sergileyebileceklerini, ayrıca bazı araştırmacıların da yetenekli ve uzman katılımcıların genellikle acemilerden veya yeni başlayanlardan daha yüksek dinamik görsel algıya sahip olduğunu belirtmektedir. CAT görevi ile ilgili olarak, deneyimli katılımcılar, acemi katılımcılar yerine, daha kesin bir sezinlemeye sahiptirler (Lyons ve diğ., 2008). Açıkçası, CAT'in becerisi önceden vurgulandığı gibi deneyimli ve daha az yetenekli katılımcıları ayırabilir. (Ishigaki ve Miyao, 1993). Gelen topun hızını ve izini tahmin etmek, özellikle vurma ihtiyacı olan sporlarda esastır (örneğin, tenis, badminton). Bu tür sporcuların, zamanında ayakları harekete geçirmek veya dönüş atışına hazırlanmak ve doğru pozisyonu elde etmek ve hazırlıklı olmak için iyi bir sezinleme zamanı yeteneğine ihtiyaçları vardır. Ayrıca, harekette olan topun raketle temas etmesi ve gelen topun yarışmacının tarafına gönderildiği an önemlidir, aksi halde zamanlamadaki küçük değişiklik sahadaki istenmeyen pozisyonlara neden olabilir (AK ve Koçak, 2010). Bu nedenle, CAT hızlı oynan sporların katılımcılarının en temel becerilerden biridir. Bu çalışma daha önce çalışılmayan sezinilme zamanı ile ilgili bazı soruları cevaplamak için (deneyimli, uyarı hızı, egzersiz şiddeti ve sedanter gibi) bazı temel faktörlerin badminton oyuncuları üzerindeki etkilerini incelemeye çalışmaktadır.

Badminton, tek bir rakibin yanında veya her iki oyuncudan oluşan iki takım arasında tek tek oynanabilen bir raket spordur (çiftler). Her oyuncu, ağın üzerinden veya etrafından keçe ile örtülmüş içi boş bir lastik topa vurmak için kordonla gerilmiş bir badminton raketi kullanmaktadır. Oyunun amacı, topu iyi bir şekilde karşıya vurmaktır. Bu sporun, bir oyun sahasındaki çeşitli yerlerdeki hızlı değişiklikleri veya modifikasyonları yapabilmek için geniş bir hızlı uzuv hareketi aralığına ihtiyacı vardır (http://emasports.weebly.com/badminton.html). Oyun sahasının boyutuna ve

harekette olan topun badmintondaki CAT testine göre hızı ile ilgili olarak, badminton oyuncularının gerçek performansını temsil eden BAT makinesindeki uygun uyarı hızı seçilmiştir. Ferrauti ve Bastiaens (2007) ve Iino ve Kojima (2009) literatürüne göre teniste iki taban çizgisi arasındaki boşluk yaklaşık 23, 8 metredir. Bir oyunda yetişkin bir bireyin topa vuruşunun hareketli badminton topunun ortalama hızı 100 km / s' iken (27 m / Sn.) Genç badminton oyuncularında daha yavaştır. Bu bilgiye dayanarak, rakiplerin topa vurduktan sonra dönüş atışına hazırlanmak için katılımcıların 1 saniyeden daha az bir sürede topa karşılık vermeleri gerekmektedir. Topun hızındaki ve katılımcılar arasındaki mesafedeki farklılıklar göz önüne alındığında, CAT çeşitli uyaran hızlarıyla (düşük, orta ve yüksek) değerlendirilmelidir. Bu nedenle, bu çalışmada CAT'i test etmek için farklı hızlar kullanılacaktır.

Son zamanlarda, doğru CAT'in hareketli bir topu almak, ele geçirmek ve vurmak için büyük bir işlev sunduğu, açık beceriler içeren neredeyse tüm spor türlerinde (örneğin hentbol ve voleybol) motor becerilerinin yetkin bir şekilde yerine getirilebileceği gösterilmiştir. Özellikle tenis, masa tenisi, squash ve badminton gibi sporlar, motor davranış ve algısal yeteneklerin yüksek kalitede uygulanmasını gerektirir (Mori, Ohtani ve Imanaka, 2002). Top oyunları (badminton, tenis) ve oyuncuları ile ilgili olarak, top oyunları oynamak bazı çocukların motor gelişimlerini diğerlerinden daha hızlı ilerletmelerine yardımcı olabileceği söylenmektedir. Benguigui ve Ripoll (1998), CAT'taki 7, 10, 13, 23 yaşındaki tenis katılımcılarını karşılaştırdı ve tenis katılımının algısal-motor ilerlemesini artırabileceğini sonucuna ulaşmıştır. Ayrıca 7 yaşındaki deneyimli tenis katılımcılarının diğer 7 yaşındaki yeni başlayan katılımcılardan daha üstün skorlara sahip olduğunu göstermektedir. Bu çalışmanın amacı, genç badminton oyuncularındaki farklı uyarı hızı, egzersiz şiddeti ve deneyim seviyesinin (deneyimli, acemi ve sedanter) sezinleme zamanlaması (CAT) performansı üzerindeki etkilerini incelemektir. Ve katılımcılar, gelmekte olan nesneyi ya da uyarıyı hedef kısmına varmak üzereyken (ışıklar seri olarak

aydınlatılmışken) raketle olabildiğince isabetli cevap vermemeleri gerekmektedir. Ayrıca CAT değerlendirmelerinin 2 farklı gün içinde 09.00 – 19.00 saatleri arasında değerlendirildiği gerçekleşmiştir. Katılımcıların test prosedürünü tanımaları ve anlamaları için çeşitli uyarı hızlarının (1, 3 ve 5 mph) her birinde 10 rastgele deneme yapılma fırsatı verilmiştir. Ayrıca, katılımcıların performansı, milisaniye (pozitif +) veya (negatif-) cinsinden değerlenmiştir ve hata payı olarak, son lambanın ışığı yanmadan önce raketle yanıt veren katılımcılara (-) veya erken puan verilmiştir ve diğer taraftan katılımcı eğer son lamba yandıktan sonra ışığa cevap verdiyse olumlu ya da geç skor olarak kaydedilerek notlandırılmıştır. BAT cihazı, koşu bandının yakınına monte edilerek katılımcıların istenen egzersiz miktarına ulaşıldığında, CAT görevlerini tamamlamak üzere herhangi bir gecikme olmadan direk ölçüme alınarak zaman kaybı faktörü riski tamamen engellenmiştir, ki bu da fiziksel çalışmaya takiben iyileşme ve iyileşme prosedürü yönünden deneysel çalışmalardaki sınırlamaları açısından çok önem taşımaktadır. Sonuç olarak, denekler gereken egzersiz şiddeti koşuluna ulaştıktan sonra (%70 veya %90) ölçüm işlemi için gecikmeden ölçüm sürecine alınmışlar (Duncan ve ark., 2013). Sunulan çalışmada dikkate alınan diğer bir faktör, test işlemi sırasında izlenen kalp atış hızıdır ki bu konu Polar (RS400, Finlandiya) cihazını kullanarak ölçülmüştür. Sunulan çalışma büyük bir ölçüde (Lyons ve diğerleri, 2008; Duncan ve diğerleri, 2013; Duncan ve diğerleri, 2014; Duncan ve diğerleri, 2015) bu araştırmacıların çalışmalarını baz alarak (HRrest) yani Dinlenik Kalp Hızı değerini elde etmek için deneklerin en az 10 dakika boyunca sırtüstü yatar pozisyonunda yatarak ve uygun yer (sessiz oda) koşulunu sağlayarak elde edilmiştir. Koşu bandında %70 HRR ve%90 HRR ne ulaşabilmek için, 5 mph da her 30 sn bir 1mph artımlı bir çalışma prosedürü uygulanmış (Lyons ve ark. 2006'a; Lyons ve diğerleri, 2008; Duncan ve diğerleri, 2013) ve doğru sonuçlar elde edebilmek için katılımcılar ulaştıkları gereken sabit durum egzersiz yoğunluğunda bir süre daha tutularak alınan kalp ritmi değerleri dikkate alınmıştır (Lyons et al., 2008 and Duncan et al., 2013). Söz konusu HRR ulaştıktan sonra, deneklerin doğrudan ayakta durarak (cihazın tam önünde ve iki

metre uzaklığında) ve her bir uyarı hızlarında (1, 3 ve 5 mph) yirmi deneme gerçekleştirilmiştir. BAT'ın uzunluğu ve farklı uyarı hızlarına göre, denekler .44sn, 1.56, 2.2 sn. her bir denemede sırasıyla düşük, orta ve yüksek uyaran hızları için verilmiştir (Akpınar ve ark., 2012). Ve elde edilen milisaniyelik puanlar + veya negatif olarak değerlendirilmiştir. Gerekli ve daha doğru kalp ritim hızını hesaplamak için Thompson, Gordon ve Pescatello (2009, s. 155) tarafından belirlenen maksimum kalp atış hızının (en doğru HRmax) uygulanmış olduğu da eklenmelidir.

Bu nedenle HRmax 206.9 eksi katılımcının yaşı ve elde edilen rakamın çarpı 0,67 olarak ölçülmüştür. Daha sonra HRrest ve HRmax, %70 ve%90 HRR'yi kaydetmek ve hesaplamak için uygulanmıştır (Lyons ve diğerleri, 2008; Duncan ve diğerleri, 2013). Örneğin, HRR'nin%70'i şu şekilde hesaplanır:

$$HR_{max} = 206.9 - \ (0.67 \times age)$$

$$Target\ Heart\ Rate\ (THR)_{70\%}$$

$$= 70\%\ of\ Heart\ Rate\ Reserve$$

$$(THR)_{\ 70\%} = \ HR_{rest} + 0.70\ (HR_{max} - HR_{rest})$$

Motor davranış alanı ile ilgili olarak (spor biliminde) katılımcıların performansı üç farklı bölümde değerlendirilebilir; a) ağırlık kaldırmadaki ağırlık sayısı gibi hareket özellikleri hakkındaki gerçekleri gösteren tepki boyutu b) zaman; sporcunun reaksiyon süresi gibi uyarana tepki gösterdiği andaki hareket süresi ve c): hatanın doğruluğu; 3 yaygın hata skoru (değişken hata, sabit hata ve mutlak hata) değerlendirilmektedir. Bu bağlamda, sunulan çalışmanın odağı, toplanan ham puan olarak verilerin ölçüm hatalarını, standart sapma olarak ifade ederek ve tutarlılık için değişken bir hataya (VE) ve doğruluk yani mutlak sabit hata (| CE |) (bağımlı değişken olarak) değerlendirilmesidir.

Bağımlı değişkenleri (|CE| & VE) açıklığa kavuşturmak için, bu değişkenleri kısaca açıklamak yararlı olabilir:

Değişken hata (VE) veya tutarlılık: Katılımcının ortalama standart sapması; bu, yanıtların değişkenliğini (tutarlılığı) gösterir ve yüksek bir VE performansın tutarsız olduğu anlamına gelirken, düşük bir VE puanların çok benzer olduğunu gösterir.
Mutlak Sabit Hata (|CE|): Mutlak sabit hata tesadüf beklentisi zamanlama puanlarının doğruluğunu ölçmektedir. Yüksek puanlar performansın yanlış olduğunu göstermektedir. Oysa daha az mutlak sabit hata daha iyi performans demektir.

a) Rastgele örnekleme (tüm katılımcılardan rastgele bir örneği temsil eden katılımcılar); b) normal dağılım (DV normal olarak popülasyonda dağıtılır; c) gözlemlerin bağımsızlığı (bireyler arasındaki puanlarda bağımlılık yoktur) d) küresellik (bir katılımcı-katılımcı faktörünün herhangi bir seviyesi arasındaki farkların varyansı, popülasyondaki tüm gruplar arasında eşittir); e) varyans homojenliği (grupların her biri için puanların değişkenliği ilişkilidir) temel alınan varsayımlardır varsayılan model ANOVA varsayılmıştır.

Katılımcılar arasındaki faktör arasındaki varyansların kalitesini kanıtlamak için Levene testi nedeniyle varyansın homojenliği tahmin edilmiştir ($p < .05$). Diğer taraftan, her bağımsız değişkenin her seviyesinde (deneyim seviyesi, egzersiz yoğunluğu ve uyaran hızı) bağımlı değişkenlerin normallik testleri (CAT performansının doğruluğu ve tutarlılığı) Kolmogorov-Smirnov ve Shapiro-Wilk'un testleri kullanılarak normallik varsayımının geçerliliğini kontrol etmek için analiz edilmiştir. Ayrıca, sphericity test etmek için Mauchly testini kullanarak, faktörler arasındaki farkların varyansının popülasyondaki tüm gruplar arasında eşit olduğunu göstermek için uygulanmıştır. (Egzersiz şiddeti ve deneyim seviyesi) (deneyim seviyesi ve uyarı hızı), (egzersiz şiddeti ve uyarı hızı) ve katılımcılar arasındaki sezinleme zamanı farklılıkları göstermek için, çalışmanın araştırma sorularına bağlı olarak bir seri istatistiksel analiz yapılmıştır. Farklı koşullarda (dinlenme, orta ve

yüksek), uyarı hızlarında (1, 3 ve 5) ve deneyim seviyesinde (sedentar, başlangıç ve deneyimli) sezinleme zamanı doğruluğu ve tutarlılığı elde edilen puanlar, Tekrarlı Ölçüm tasarımı yapılarak ayrı ayrı analiz edilmiştir.

Gurup içerisindeki faktörler egzersiz şiddeti (dinlenme, orta ve yüksek) ve uyarı hızlarıyken (1, 3 ve 5 mph) gruplar arasındaki faktör ise egzersiz şiddetidir. Bu çalışmanın bağımlı değişkenleri |CE| ve VE, bağımsız değişkenleri ise deneyim düzeyi, egzersiz yoğunluğu (sedanter, acemi ve deneyimli) ve uyarı hızıdır (1, 3 ve 5).

YÖNTEM

Bu çalışmaya gönüllü olarak toplam 139 kişi katılmıştır. Bunlar Badminton oynayan deneyimli (n=43), acemi (n=42) ve sedanter ler (n=54) olarak üç gruba ayrılmıştır. Literatüre göre (Benguigui ve Ripoll, 1998; Williams ve diğerleri, 2002; Ak ve Koçak, 2010) gençlerde, CAT yeteneğinin gelişimi beş ile on bir yaş aralığında olmaktadır (Williams ve diğerleri, 2002; AK ve Koçak, 2010). Çalışmaya 43 deneyimli badminton sporcusu (20 erkek ve 23 kız) katılmıştır. Deneyimli katılımcılar 11 ile 16 (M = 13.20, SD = 1.46) yaş arasında olup badminton oynamak için ortalama tecrübeye (M= 4,90 yıl SD = 1.31) sahiplerdir. Aynı yaş aralığındaki acemi katılımcıların 22'si erkek ve 20'si kız olan katılımcılar toplamda 42 kişiden oluşmaktadır (M = 12.84, SD = 1.28). Acemi katılımcıların spor deneyimleri M = 1.50 yıldır (SD = .90). Sedanter grupta yaşları 11 ila 16 yıl arasında değişen (M = 13.48, SD = 1.42) toplamda 54 katılımcı vardır (28 erkek ve 26 kız). Sedanter katılımcılar düzenli olarak 6 aydan fazla bir süredir sportif faaliyetlere katılmamıştır. Bu nedenle, Orta Doğu Teknik Üniversitesi'nden etik onay alındıktan sonra, yaşları 11 ile 17 arasında olan söz konusu katılımcılar deney ortamına katılmışlardır. Deneyimli oyuncular en az 3 yıl badminton sporuna katılım geçmişlerine sahipti ve haftada en az üç kez antrenman seanslarında ve ulusal yarışmalarda yer almışlardır. Katılımcıların tanımlayıcı istatistikleri aşağıdaki gibidir: Deneyimli katılımcılar için yaş ve deneyim düzeyinin

ortalama ve standart sapması sırasıyla 13.20 ± 1.46 ve 4.90 ± 1.31'dir. Acemi grup için yaş ve spor katılımının ortalama ve standart sapması sırasıyla 12.84 ± 1.28 ve 1.50 ± .90 idir. Bu çalışmada katılanların CAT becerilerini ölçmek için, değerlendirme sürecinde Abernethy ve Wood (2001) tarafından uygun bir ölçüm cihazı olduğuna dair kanıt bulunan Bassin Anticipation Timer cihazı (Model 35575, Lafayette, ABD) kullanılmıştır. BAT cihazı bir yanıt düğmesinden (hedef ışığın aydınlatılmasını öngörmek için tepki vermek için uygulanır), raket, kontrol konsolu ve köpüklü-dokuz doğrusal LED ışık dizisine sahip sıralı bir seriden oluşur. BAT cihazı, koşu bandının önüne monte edilmiştir böylece gereken egzersiz yoğunluğu egzersizinin alınmasından sonraki ertelemeleri en aza indirgemiştir. Bu çalışmada BAT cihazı uygulanmıştır çünkü genellikle CAT doğruluğunun ölçümünde kullanılır (Diggles-Buckles & Bassin, 1990; Abernethy & Wood, 2001; Rodrigues, Vasconcelos, Barreiros ve Barbosa, 2009; Sanders, 2011; Rodrigues, Barbosa), Carita, Barreiros ve Vasconcelos, 2012). Ayrıca, softball katılımcılarının vuruş yeteneğini geliştirmek için BAT cihazı faydalı bir eğitim cihazı gibi görünmektedir (Kuhlman ve Beitel, 1992). Ayrıca, Akpınar ve arkadaşları (2012) ve Ramella ve Wiegand (1983) 'de belirtildiği gibi BAT cihazı, farklı uyarı hızlarıyla ilgili hataları belirlemek için güvenilir ve pratik bir cihaz olarak görülmüştür.

Bu çalışma tekrarlı bir repeated measures uygulanmıştır ve kullanılan tüm işlemler Orta Doğu Teknik Üniversitesi Etik Kurulu birliği tarafından onaylanmıştır ve katılımcılar, antrenörler ve velileri tarafından onay mektubu imzalanmıştır. Bu form imzalanmadan önce çalışmayla ilgili tüm bilgiler ve detaylar katılımcılara anlaşılır bir şekilde açıklanmıştır. Katılımcılar çalışma hakkında tamamen aydınlandıktan sonra formları doldurmuşlardır. Tüm katılımcılara BAT (Model 35575, Lafayette, ABD) cihazını tanımaları ve aşina olmaları için 10 deneme yapılmıştır. Tüm katılımcılara 3 test seansına dahi edildiler ve test seansları öncesinde hazır olmaları ısınmaları ve esneme yapmaları için 5 dakika verilmiştir.

Bu çalışmanın amacı doğrultusunda, her katılımcı uyarı hızına göre 3 farklı deneme ortamı düzenlemiştir (1, 3 ve 5 mil hız); ve egzersiz yoğunluğuna göre üç farklı deneme ayarı (istirahat, 1, 3 ve 5 mil hızında orta derecede egzersiz yoğunluğu olarak %70 HRR; 1, 3 ve 5 mil hızında yüksek egzersiz yoğunluğu olarak%90 HRR). Farklı durumlar üzerinde yapılan tüm testlerin, şartlar altında uygulamalı ve acemi katılımcıların 3 parça halinde alınmasıyla dengelenmesi olmalıdır: Oyuncuların 1 / 3'ü %70- %90 HRR ve 90 sırasına göre test edildi. 1, 3 ve 5 mph uyaran hızlarında %- %70 HRR, 1/3 3,5 ile %70- % HRR ve %90-% HRR ile 3, 5 ve 1 mph uyaran hızları ile diğer katılımcıların siparişleri 1 / 3, 5, 1 ve 3 mph uyaran hızlarıyla. Ayrıca, hareketsiz katılımcılar, istirahat durumunda, belirtilen hızlarda toplanarak değerlendirildiler: (1, 3, 5 mil, 3, 5, 1 mil ve 5, 1, 3 mil). Bu araştırmaya katılanların test edildikleri hız oranlarını veya test seansları sırasında veya sonrasında test prosedürü üzerindeki puanlarını bilmelerine izin verilmedi, bunu yaparak önyargıları azaltılmıştır ve görev komplikasyonunun etkisine son verilmiştir. Badminton'un yüksek seviye yoğunluğu gerektiren hızlı bir top oyunu olması nedeniyle, CAT, üç farklı uyarı hızında (1, 3 ve 5 mph) ve 3 değişik egzersiz yoğunluğunda (dinlenme, orta ve yüksek) badminton katılımcıları arasındaki deneyim seviyesi farklılıkları nedeniyle uygulanmıştır. Deneklerin uyarı hızlarını tahmin etmemeleri adına bahsedilen üç farklı uyarı hız rasgele olarak en aza erteleme (1 ve en yüksek 2 sn erteleme) süresiyle uygulanmıştır.

SONUÇLAR

Uyarı Hızı (1, 3 ve 5) ve Deneyim Düzeyi (Deneyimli, acemi ve sedanter)

Değişken Hatası (VE):

Etkileşim Etkisi (VE): Mixed ANOVA sonuçları, değişken hata için farklı performans düzeylerinde (deneyimli, acemi ve sedanter) ve farklı uyarı hızlarında (1 mph, 3 mph ve 5 mph) olan katılımcılar arasında etkileşim olmadığını göstermiştir (F (2.270) =

1.46, p> .05), bu durumda Dinlenme durumunda 1, 3 ve 5 mil hız uyarı hızlarında CAT deneyiminin tutarlılığını farklı deneyim seviyedeki katılımcılar arasında önemli ölçüde değişmediğini göstermektedir.

Ana Etkiler (within subjects): Sonuçlara göre, dinlenme durumunda CAT üzerinde farklı uyarı hızı seviye durumunda deneyimli, acemi ve sedanter katılımcıların arasında önemli bir fark olduğunu göstermektedir.

Between subjecys effects: Sonuçlara göre, dinlenme durumlarında CAT üzerinde olan üç farklı uyarı hızı seviyesi deneyimli, acemi ve sedanter katılımcılar arasında önemli fark olduğunu göstermiştir (F (2.136) = 12.6, η2 = .16, p <.05). Bu etki tespit edilirken, etkinin nedenini belirlemek için takip testi yapılmıştır. Sonuçlar deneyimli badminton oyuncularının acemi badminton oyuncuları ve sedanter katılımcılardan daha iyi performans gösterdiğini göstermiştir (p <.05). Sonuçlar ayrıca acemi badminton oyuncuları ile sedanter katılımcılar arasında fark olmadığını göstermiştir (p> .05).

Mutlak Sabit Hatası (| CE |):

Etkileşim Etkisi: | CE | mutlak hata için dinlenme durumunda CAT üzerinde farklı uyarı hızlarında deneyimli, acemi ve sedanter katılımcılar arasında etkileşim olmadığını (F (2,270) = .23, p> .05) göstermiştir, ki bu sonuç sezinleme zamanı puanlarının doğruluğunun gösterdiğini ortaya koymuştur. Ayrıca sezinleme zamanı dinlenme durumunda farklı uyarı hızlarında deneyimli, acemi ve sedanter katılımcılar arasında önemli ölçüde değişmemiştir.

Ana Etkiler (between subjects effects): Sonuçlara göre, dinlenme koşulunda farklı uyarı hızlarında deneyimli, acemi ve sedanter katılımcılar arasında anlamlı bir fark görünmüştür (F (1.76, 239.15) = 105.09, η2 = .44, p <.05)

Ana Etkiler (within subjects effect): Sonuçlara göre, dinlenme koşulunda farklı uyarı hızlarında deneyimli, acemi ve sedanter katılımcılar arasında anlamlı bir fark tespit edilmemiştir ($F (2,136) = 1.13, p > .05$).

Egzersiz şiddeti (%70) ve Deneyim Seviyesi (deneyimli & acemi)

Değişken Hatası (VE):

Etkileşim Etkisi: |VE| değişken hata için %70 egzersiz şiddeti koşulunda CAT üzerinde farklı uyarı hızlarında deneyimli ve acemi katılımcılar arasında etkileşim olmadığını ($F (2, 82) = .99, p > .05$) göstermiştir ki bu da sezinleme zamanı puanlarının doğruluğunu işaret ettiğini ortaya koymaya yeterli olmuştur ve ayrıca %70 egzersiz şiddetinde farklı uyarı hızlarında deneyimli ve acemi katılımcılar arasında önemli bir değişiklik olmadığı görülmüştür.

Ana Etkiler (within subjects effects): Analizlerin sonuçlarına göre, %70 egzersiz şiddetinde her iki grubun uyarı hızları arasında anlamlı farklılıklar vardır ($F (1.89, 157.02) = 12.85, \eta 2 = .13, p <.05$)

Ana Efektler (between subjects effects): Sonuçlara dayanarak, deneyimli ve acemi badminton oyuncuları arasında anlamlı bir fark olmadığını göstermiştir ($F (1, 83) = 1.46, p > .05$).

Mutlak hata:

Etkileşim Etkisi: Mixed ANOVA sonuçlarına göre, egzersiz şiddetiyle ile deneyimli-acemi arasındaki durum CAT performansı üzerinde etkileşim olmadığını göstermiştir ($F (2, 82) = .79, p > .05$).

Ana Etkiler (within subjects effects): Sonuçlara göre, her iki grubun uyarı hızları arasında anlamlı farklılıklar vardır ($F (1.63, 135.49) = 113.34, \eta 2 = .58, p <.05$).

Ana Etkiler (between subjects effects): Ana etki sonuçlarına göre, deneyimli ve acemi badminton oyuncuları arasında anlamlı bir fark görülmemiştir ($F (1, 83) = .88$, $p > .05$).

Egzersiz şiddeti (%90) ve Deneyim Seviyesi (deneyimli, acemi)

Değişken Hatası (VE):

Etkileşim Etkisi: Mixed ANOVA sonuçlarına göre, egzersiz şiddeti (%90) ve CAT performansı üzerinde olan deneyimli-acemi arasında bir etkileşim olmadığı görülmektedir ($F (2, 82) = .54$, $\eta 2 = .01$, $p > .05$).

Ana Etkiler (within subjects): Analiz sonuçlarına göre, her iki grubun uyarı hızları arasında önemli farklılıklar vardır.

Ana Etkiler (between subjest effects): Analiz sonuçlarına göre, deneyimli ve acemi badminton oyuncular arasında anlamlı bir fark olmadığı görülmüştür ($F (1, 83) = 1.54$, $p > .05$).

Mutlak hata:

Etkileşim Etkisi: Karışık ANOVA sonuçlarına göre, egzersiz şiddeti ile deneyimli-acemi arasındaki durum CAT performansı üzerinde önemli etkileşim olmadığını göstermiştir ($F (2, 82) = .58$, $\eta 2 = .01$, $p > .05$)

Ana Etkiler (within subjects effects): Sonuçlar her iki grubun uyarı hızları arasında önemli farklılıklar olduğunu göstermiştir.

Ana Etkiler (between subjects effects): Sonuçlara göre, deneyimli ve acemi badminton oyuncuları arasında anlamlı bir fark yoktur ($F (1, 83) = .00$, $\eta 2 = .00$, $p > .05$).

TARTIŞMA VE ÖNERİLER

Uyarı Hızları (1, 3 ve 5) ve Deneyim Düzeyi (Deneyimli, acemi & sedanter):

Lyons ve diğ. (2013) uzman olmayan ve profesyonel tenis oyuncularında ki orta ve yüksek yoğunluklu yorgunluğun etkisini zemin vuruşu üzerindeki etkilerini araştırmıştır ve bu araştırmada 17 uzman olmayan ve 13 deneyimli oyuncu araştırmaya dahil olmuştur. Karışık ANOVA'nın sonuçlarına göre, yeterlilik durumunu göz ardı ederken bile orta (%70) ve yüksek (%90) egzersiz şiddetleri önemli bir seviyede yorgunluk etkileri Loughborough Aralıklı Tenis Testini etkilediğini göstermiştir. Bununla birlikte, deneyimli katılımcılar, acemi katılımcılarla eşleşen tüm durumlarda daha iyi bir iniş doğruluğu sağladığı tespit edilmiştir. Ayrıca, orta yorgunluk seviyesi ve dinlenme durumundaki zemin vuruşu doğruluğu ve etkisi, sunulan çalışmanın bulgularını desteklemiştir. Williams ve diğ. (1994) futbolcularda (Tecrübeli ve tecrübesiz) açık oyun koşullarında taktik beklentisi ve temel Beceri sapmalar konusunda bir araştırma yürütmüştür. Sonuçlar, deneyimli katılımcıların daha iyi sezinleme performansı olduğunu göstermiştir.

Literatür taramasında, az sayıda araştırmanın farklı uyarı hızlarının sezinleme zamanı performansında olan etkisini ortaya koymuştur ve buda belirsiz sonuçların ortaya çıkmasına neden olmuştur (Williams ve diğerleri, 2002; Duncan ve diğerleri, 2013; Duncan et al., 2015). Aslında, katılımcılar tarafından gerçekleştirilen performansın sezinleme zamanlaması konusunda mutlak ve güvenilir sonuçlar elde edilmesi için önemli bir esas sayılmaktadır.

Farklı egzersiz yoğunluğu etkisini araştırırken farklı uyarı hızları etkisinde aynı zamanda ana özellik olarak vurgulanmaktadır (Fleury & Bard, 1985). Son çalışmalara bakıldığında (Sanders, 2011), zayıf sezinleme performansının dinlenme koşulunda daha yüksek uyarı hızlarıyla ilişkili olduğu görülmektedir. Wrisberg ve diğ. (1982), mutlak hata ve değişken hatalar arasındaki farkı görmek için uyarı hızının sezinle

becerisi üzerindeki etkisini incelemiş ve sonuçlar daha yüksek uyarı hızlarının daha düşük mutlak hataya ve değişkene neden olduğunu ve katılımcılar tarafından geç cevap verebileceğini göstermiştir.

Williams ve diğ. (2002), uyarıcı hızının CAT performansı üzerindeki etkisi ile ilgili bir çalışma yürütmüş ve sonuçlar erkek oyuncuların düşük uyarıcı hızında (6 mil / saat) kadınlarla karşılaştırdığında daha tutarlı olduğunu göstermiştir ki bu sonuç sunulan çalışma ile uyumlu olduğunu göstermiştir. Bu çalışmanın yazarları, CAT performansının pratik olarak geliştirildiğini ve ekolojik taleplerdeki sapmalara uyarlanabilir olduğunu belirtmiştir. Yazarlar ayrıca yanıt zamanlamasının, algısal reaksiyonların ve motor yanıtlarının sürekli süreçlerinin kombinasyonu ile senkronize olabileceğine inanmaktadır.

Lyons ve ark. (2008), çeşitli egzersiz şiddetinin CAT performansına olan etkilerini (uzman ve acemi katılımcılarda) görmek için, Bassin sezinleme zamanı cihazını 5 mil / saat (uyarıcı hız olarak) kullanarak bir çalışma yürütmüşlerdir. Sonuçlar, deneyimli katılımcılarının sezinleme zamanı performansını tüm test prosedürlerinde koruyabileceğini, acemi olanların ise CAT'ı sadece %70 egzersiz yoğunluğunda (orta yoğunlukta) gerçekleştirebileceğini ortaya koyduğunu göstermiştir. Ayrıca, tüm katılımcılar, 5 mil / saat hızda doğru CAT skorları gerçekleştirdiklerini göstermiştir ki buda sunulan çalışmanın bulgularını desteklemektedir.

Egzersiz şiddeti (%70) ve Deneyim Seviyesi (deneyimli & acemi):

Literatür derlemesine bakıldığında, yorgunluk veya farklı egzersiz şiddetinin CAT performansı üzerindeki etkileri konusunda tutarsız sonuçlar ortaya çıkmıştır. Duncan ve arkadaşları (2013) bu farklılıkların kaynağının çeşitli yöntemler, farklı yoğunluk türleri, farklı sporcular, çeşitli uyarı hızları ve spora katılım geçmişi ile ilgili olduğunu belirtmiştir. Lyons ve ark. (2008), çeşitli egzersiz şiddetlerin CAT performansında olan etkilerini görmek için, Bassin anticipation timer cihazını 5 mil / saat (uyarıcı hız

olarak) ayarlayarak uzman ve acemi katılımcıların üzerinde önemli bir çalışma yürütmüşlerdir. Sonuçlar, deneyimli katılımcıların sezinleme zamanı performansının tüm test prosedürlerinde koruyabildiğini ortaya koyarken, acemi olanlar CAT'ı sadece %70 egzersiz şiddetinde (orta şiddet seviyesi) gerçekleştirebilmişlerdir. Al-Nakeeb ve Lyons (2007), CAT performansının farklı egzersiz şiddeti altında değişmediğini ve bu çalışmaların bulgularını desteklediğini belirtmiştir (Bard ve Fleury, 1978; Fleury & Bard, 1985, 1987; Fleury, Bard, 1981).

Literatür taramasını baz alarak, farklı egzersiz şiddetleri, çeşitli deneysel tasarımlar, çeşitli yöntemler ve farklı uyarı hızların seçimi sezinleme zamanı performansı konusunu ile ilgili olarak isabetsiz ve çeşitli sonuçların gösterdiğine neden olmuştur. Hata motor ve bilişsel beceriler konusunda bile önemli farklılıklar bulunmuştur (Aks, 1998). Sonuç olarak, önceki egzersiz yoğunluğundan iyileşme prosedürü ile ilgili olarak bazı araştırmalarda katılımcıların performansı gerçek bir efor performansı formunda değerlendirilmemiş olabilirler. Brisswalter ve diğ. (2002) araştırmacılar tarafından katılımcıların fiziksel uygunluk durumuna dikkat edilmemesinin araştırma çalışmalarındaki en kritik ve önemli konulardan biri olduğunu ve çalışmaların sonuçlarını değiştirebileceğini, ayrıca motor becerilerin (tüm vücut hareketi) faaliyetler sırasında değerlendirilmelerini beyan etmektedir (McMorris ve Keen, 1994). Öte yandan Lyons (2011, s. 57) “laboratuvar araştırmaların prosesini sıkı bir şekide kontrol edilmesi gereken koşulları varken, bazı bilim adamları, İnsan performansını etkileyen var olan tüm değişkenlerin yeterli derecede dikkate almadıklarını ve araştırma yapma konusunda isteksiz olduklarını söylemektedirler ki kolayca kontrol edilebilecek bir durum değildir”.

Sözü edilen çalışmalarla dayanarak, egzersiz şiddetinin katılımcıların performansı üzerindeki etkilerine göz önünde bulundurarak literatürde sınırlamalar ve eksiklikler olduğu görünmektedir ki çalışmalarda uygulanan sistemler ve yöntemlere göre farklı sonuçlar elde edilmesine neden olmuştur. Duncan ve diğ. (2013), koşu bandı

kullanarak uyarı hızı ve egzersiz şiddetinin CAT skorları üzerindeki etkileriyle ilişkin bir çalışma yürütmüşler ve sonuçlar, egzersiz şiddetinin CAT performansını olumsuz etkilediğini (3 ve 5 mph uyarı hızlarında) göstermiştir, ayrıca%70 egzersiz şiddetinde katılımcıların CAT performanslarının doğruluğu 5 mph uyarı hızında daha iyi olduğu tespit edilmiştir. Öte yandan, sonuçlar farklı egzersiz şiddetlerinde (düşük uyarı hızında) katılımcıların performansında önemli bir farklılık olmadığını belirtmiştir. Son olarak sonuçlara bakıldığında, yüksek düzeyde egzersiz şiddetinin ve çok hızlı olan uyarı hızlarında sezinleme zamanının puanlarını olumsuz yönde etkilediğini belirtilmiştir.

Egzersiz şiddeti (%90) ve Deneyim Seviyesi (deneyimli, acemi)

Egzersiz şiddetinin etkisini araştırmak için Sibley, Etnier ve Le Masurier (2006) Stroop colour-word testini katılımcıların performansını değerlendirmek için kullanmışlar ve sonuçlar orta şiddetli egzersizin ve yirmi dakika koşmanın test sonuçlarını daha iyi yaparak pozitif yönde etkilediğini göstermiştir. Bu çalışma doğrultusunda Lyons (2011) egzersiz şiddetini üç farklı seviyede (dinlenme, %50 nabız ve %80 nabız) koşullarında aynı test yöntemini kullanarak (ergometresi üzerinde) etkisini değerlendirmiştir. Sonuçlar, yüksek egzersiz şiddetinin spor aktivitelerinde zayıf performans kaynağı olabileceğini göstermiştir. Ancak diğer çalışmalara bakıldığında farklı egzersiz şiddetleri koşulunda (Stroop testi) katılımcıların performansında önemli bir farklılık olmadığını göstermiştir.

Hareketlerin ve hareket halinde olan nesnelerin ya da topun hızını tahmin etmek, spordaki önemli konulardan biri sayılmaktadır ve spor katılımcılarının özellikle elit olan oyuncuların bu yeteneğe sahip olmaları elzem beceri olarak görünmektedir (Tenenbaum ve diğerleri, 2000). Al-Nakeeb ve diğ. (2005), egzersiz şiddetinin CAT performansı üzerindeki etkilerini göz önünde bulundurarak, yeni başlayanları ve deneyimli oyuncuları üç farklı koşulda; Bassin Anticipation timer aparatından yararlanarak, egzersiz şiddetini kürek ergometresiyle üç farklı seviyede yani: a)

dinlenme, b) %70 kalp atış hızı ve c) %90 kalp atış hızına çıkarak karşılaştırma yapmışlar. Elde edilen sonuçlara göre, üç farklı egzersiz şiddeti koşulunda ve aynı zamanda sabit ve değişken hataları göz önünde bulundurarak deneyimli ve acemi katılımcılar arasında önemli fark görünmemiştir, ki bu sonuç sunulan çalışmanın sonuçlarını desteklemiştir.

Aynı araştırmacılar (2007'de), farklı egzersiz şiddetlerinin (istirahat, %50 ve%80 kalp atış hızı) CAT performansı üzerindeki olan etkilerini görmek için önemli bir çalışma yürütmüşler ve elde edilen sonuçlar, tüm koşullarda iki grup arasında önemli bir fark olmadığını göstermiştir. Bu çalışma doğrultusunda Lyons (2011), yüksek egzersiz şiddeti koşulu katılımcıların CAT performansını olumsuz yönde etkilemediğini ortaya koymuşlar. Bununla birlikte, farklı egzersiz şiddetlerinin CAT yeteneği üzerindeki etkisi, gerçekleştirilen görevin yerine getirilmesiyle ilgili olarak değişebilmektedir.

Spor alanında, oyuncular için yüksek düzeyde çaba ile verimli bir şekilde ele alınmaması, yaralanma tehdidinin artmasına, konsantrasyonun azaltılmasına, gerekli performansın etkinliğinin azalmasına ve oyunların kazanmamaları için çok önem taşımaktadır (Lyons, 2011). Egzersiz şiddeti (Yorgunluk), karmaşık yapısı ve çok yönlü mekanizması nedeniyle araştırmacıları, uzmanları, yarışmacıları ve eğitmenleri kendine çeken yeni bir alan sayılmaktadır (Lyons ve diğerleri, 2013; Duncan ve diğerleri, 2014). McMorris (2004) yorgunluk ve fiziksel aktivite etkilerinin spor performansındaki etkilerinin incelenmesinin eksik olduğunu belirtmiştir. Sonuç olarak, spor bilimindeki bilişsel, motor ve algısal performansa geçerek farklı egzersiz şiddeti türleri açısından çok çeşitli araştırmalara ihtiyaç duyulmaktadır. Brisswalter ve arkadaşları (2002), çeşitli çalışma tekniklerinin, yorgunluğun bilişsel performans üzerindeki etkilerinin neden hala belirsiz olduğunu ve çeşitli kriterlere dayanan farklı bir deneysel tasarım kullanarak çalışmaların sonuçlarının tutarsız sonuçlar gösterdiğini açıklayabildiğini belirtmiştir.

Örneğin, bazı çalışmalarda koşu bandı cihazı (Al-Nakeeb ve al., 2005) ve ergometre kürek çeken döngü ergometresini (Duncan et al., 2015) kullanarak Görsel becerisinin performans üzerindeki etkilerini incelemiştir. Aks (1998), iki farklı koşulda bisiklet (egzersiz yoğunluğu olarak) kullanarak 18 katılımcıdan oluşan bir çalışma yürütmüştür: a) normal döngüde 10 dakikalık düşük egzersiz yoğunluğuna verilerek (%65), b) bilişsel performanstaki doğruluk ile ilgili olarak yüksek (%65'te 8 dakika, %85'te 2 dakika). Şaşırtıcı bir şekilde, katılımcıların performansı (doğruluk) daha hızlı ve doğru olarak görsel arama becerisi üzerinde etki göstermiştir. Ayrıca, vücut bilişsel performansı korumak için yüksek egzersiz yoğunluğunu idare etme yeteneğine sahiptir, bu da egzersiz yoğunluğunun bilişsel görevlerin performansı üzerinde hiçbir etkisi olmadığını göstermiştir (Tomporowski, 2003).

Diğer çalışmalar, egzersiz şiddetinin bilişsel performansı geliştireceğini (Brisswalter ve Ark., 2002) ve aynı zamanda karar verme becerisini (McMorris ve Graydon, 1996) destekleyerek egzersiz yoğunluğunun bilişsel performansı olumlu yönde etkilediğini belirtmiştir. Lyons ve diğ. (2011), yorgunluğun spor becerileri üzerindeki etkisine bağlı olarak yüksek ve orta egzersiz yoğunluğunun spor beceri performansı üzerine etkisini incelemişlerdir. Bahsedilen araştırmacılar, deneysel tasarımlarında istirahat, %70 ve %100 egzersiz yoğunluğunda futbolda pas verme testini kullanmışlar ve sonuçlar, %70 egzersiz şiddetinde futbolda pas verme becerisi dinleme ve %100 egzersiz yoğunluğu koşullarından daha iyi olduğunu göstermiştir.

ÖNERİLER

1. (%70 HRR) orta egzersiz yoğunluğu ve (%90 HRR) yüksek egzersiz yoğunluğu olarak gerçek badminton oyunlarında gerçek yorgunluk yüzdesini göstermeyebilir, gerçek badminton eğitiminden sonra bir test prosedürünün uygulanması önerilebilir.

2. Bu çalışma tenis gibi farklı fastball sporlarına uygulanabilir. Ayrıca, daha ileri araştırmalardaki değişiklikleri görmek için çeşitli yaşlarda denenebilir.

3. Katılımcıların diyet türü ve beslenmesi mümkün olduğunca dengelenmeye çalışılmalıdır.

4. Katılımcılar, Bassin Anticipation Timer cihazına bağlı normal bir duruş pozisyonunda bir raket ile farklı uyarı hızlarına geri döndüler, test prosedüründe koşarken topa vurmak gibi farklı pozisyonlarda bir test uygulamak yararlı olabilir.

5. Acemi ve deneyimli oyuncuların CAT performanslarındaki performansı arasındaki potansiyel farkları ortaya çıkarmak için katılımcıları çeşitli egzersiz yoğunlukları altında daha yüksek uyarı hızlarına dahil etmek yararlı olabilir.

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