# THE EFFECTS OF RHYTHM TRAINING ON TENNIS PERFORMANCE

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**ABSTRACT**

THE EFFECTS OF RHYTHM TRAINING ON TENNIS PERFORMANCE

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The purpose of the study were; to compare the effects of tennis specific and general rhythm training on the forehand consistency performance, rhythmic competence, tennis playing level and agility performance, and to examine the effects of different tempos on rhythmic competence of tennis players. 30 university students whose mean score of International Tennis Number (ITN) was 7.3 (SD=0.9) were divided randomly into three sub-groups: tennis group (TG), general rhythm training group (GRTG), and tennis-specific rhythm training group (TRTG). Measurement instruments were ITN, Agility Test, Rhythmic Competence Analysis Test (RCAT), and Untimed Consecutive Rally Test (UCRT). A Kruskal-Wallis Test was conducted to calculate possible differences between initial scores and to compare improvement scores of groups. A Mann-Whitney U Test was conducted to determine pairwise comparisons of groups for improvement scores and to analyze RCAT scores for different tempos. Results revealed that participants in both rhythm training groups (GRTG and TRTG) improved their forehand consistency performance and rhythmic competence significantly after training period. Results for the improvement scores indicated that there was significant difference in UCRT (3m) between TRTG and TG and in RCAT (50) between both rhythm training groups and TG. On the other hand, participation to additional rhythm trainings was unable to differentiate tennis playing level and agility performance of groups. There was no significant difference between rhythm training groups for all parameters tested. Results also revealed that synchronization of participants' movements with the external stimulus was more precise at fast tempo than at slow tempo.

Key Words: Tennis, Forehand Consistency Performance, Rhythm, Rhythm Training, Rhythmic Competence

# ÖZ

## RİTİM ANTRENMANININ TENİS PERFORMANSINA ETKİSİ

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Bu araştırmanın amacı; tenise özgü ve genel ritim antrenmanlarının forehand istikrar, ritim beceri, tenis oynama seviyesi ve çeviklik performansına etkilerinin karşılaştırılması ve farklı tempoların tenis oyuncularının ritim becerilerine etkilerinin incelenmesidir. Uluslararası Tenis Numarası (ITN) ortalamaları 7,3 (SS=0,9) olan 30 üniversite öğrencisi tesadüfi seçim yöntemi ile üç ayrı gruba dağıtılmışlardır; tenis grubu (TG), genel ritim antrenmanı grubu (GRAG) ve tenise özgü ritim antrenmanı grubu (TRAG). Araştırma süresince bütün gruplara önceden belirlenen tenis antrenmanları uygulanmıştır. TG sadece tenis antrenmanlarına, GRAG ek olarak genel ritim antrenmanlarına ve TRAG ek olarak tenise özgü ritim antrenmanlarına katılmıştır. Verilerin toplanmasında ITN, Çeviklik Testi, Rhythmic Competence Analysis Test (RCAT), ve Untimed Consecutive Rally Test (UCRT) ölçüm araçları kullanılmıştır. Grupların ön test değerleri arasındaki farkların ve gelişimlerinin analizinde Kruskal-Wallis testi, ön, ara ve son test değerleri farkları için ise Wilcoxon Testi kullanılmıştır. Grupların gelişim değerlerinin eşleştirilmeli karşılaştırılmasında ve farklı tempolardaki RCAT değerlerinin analizinde Mann-Whitney U testi kullanılmıştır. Araştırmadan elde edilen bulgular ritim antrenmanlarına katılan tenis oyuncularının forehand istikrar ve ritim beceri performanslarını anlamlı bir şekilde geliştirdiğini, tenis grubundaki katılımcıların değerlerinde ise bir fark olmadığını

göstermiştir. Gelişim değerleri incelendiğinde, UCRT (3m) değerleri için TRAG ile TG arasında ve RCAT (50) değerleri için ritim antrenman grupları ile TG arasında anlamlı bir fark olduğu bulunmuştur. Ritim antrenmanlarına katılımın grupların tenis oynama seviyesi ve çeviklik performanslarına etkisinin olmadığı anlaşılmıştır. Ayrıca, farklı ritim antrenmanlarındaki tenis oyuncularının gelişim değerleri arasında anlamlı bir farklılık olmadığı ve katılımcıların ritim becerilerinin, yavaş tempoya oranla hızlı tempoda daha yüksek olduğu bulunmuştur.

Anahtar Kelimeler: Tenis, Forehand İstikrar Performansı, Ritim, Ritim Antrenmanı, Ritim Becerisi

To My Parents, My Sister, and My Brother

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## TABLE OF CONTENTS

## LIST OF TABLES

## LIST OF FIGURES

## LIST OF ABBREVIATIONS

| | | |
|---|---|---|
| AT | : | Agility Test |
| BPM | : | Beats Per Minutes |
| BR | : | Beat Range |
| CPG | : | Central Pattern Generators |
| GRTG | : | General Rhythm Training Group |
| ITF | : | International Tennis Federation |
| ITN | : | International Tennis Number |
| RAS | : | Rhythmic Auditory Stimulation |
| RCAT | : | Rhythmic Competence Analysis Test |
| TG | : | Tennis Group |
| TRTG | : | Tennis-Specific Rhythm Training Group |
| TTA | : | Tennis Training Age |
| UCRT | : | Untimed Consecutive Rally Test |

# CHAPTER I

# INTRODUCTION

Previous studies reported the existence and importance of rhythm in sport skills. Weikart (1989) asserted that swimmers are getting their own beat by moving their arms and legs in coordinated pattern of strokes and kicks. In addition, Zachopoulou et al. (2000) pointed out that swimming skills require performing of a constant rhythm. According to Laurence (2000), rhythmic abilities facilitate the success in ballet. Besides, dance movements are performed in rhythmic structure and are affected by the elements of rhythm (Kirchner & Fishburne, 1995). Pica (1998) suggested that gymnastics, movement and rhythm are connected to each other. In addition, Borysiuk and Waskiewicz (2008) claimed that the fencer's footwork rhythm provide information about the distance between the fighting opponents. Shaffer (1982) reported that sense of rhythm applied to ball games provide attitudes of calmness and fluency for performers. Zachopoulou et al. (2000) stated that there is an external stimulus to which the basketball and tennis players are forced to sycnchronize their movements, and production of ryhthm for the same movements for a long duration is compulsory for the athletes.

Thaut (2005) stated that the human brain is unique to perceive and produce rhythm which is a complex time organization. Kirchner and Fishburne (1995) defined rhythm as the ability to repeat an action or movement with regularity and in time to a particular pattern.

The elements of rhythm were prescribed by Gallahue (1982) as; accent (the emphasis given to any one beat), tempo (the pace of the movement and music), intensity (the loudness or softness of the movement or music), underlying beat (the steady, continuous sound of any rhythmical sequence), and rhythmic pattern (a group of beats related to the underlying beat). Pangrazi (2007) suggested that most of the movements within physical education include elements of rhythm.

Zachopoulou and Mantis (2001) asserted that comprehending the relationship between rhythmic ability and motor skills is necessary to develop training programs. Trump (1987) stated the paucity of information about the optimal methods for rhythmic training which can be effective in developing rhythmic skills. According to Pangrazi (2007), locomotor skills are naturally rhythmic in production, and supplementary rhythm can provide progression for these skills.

Increasing popularization and professionalism in tennis forces coaches and teaching staff to be more aware of the scientific findings of studies related with the fundamentals of the game. This development also stimulates the scientists, dealing with tennis, to investigate and conduct more researches about the factors effecting performance in tennis (Christmass et al., 1995). Perry et al. (2004) claimed that studies examining the various physical characteristics of tennis are insufficient. Some practitioners stated that "co-ordination, agility, speed, and power are considered by the majority of coaches as the most important components on which tennis players should concentrate their training efforts" (Crespo & Miley, 1998, p. 149). According to Schönborn (2003), timing is the most important and decisive characteristic of good tennis players. Bourquin (2003) suggested that since the tennis players do not come across with the same ball twice due to different speed, spin, and the height of the ball, coordination is a very demanding ability for tennis.

Coordination was defined by Gallahue (1982) as the rhythmical integration of motor and sensory systems into a harmonious working together of the body parts. Bourquin (2003) stated the five coordination skills, which permit tennis players to control, pace, improve and supply rhythm to movements. These specific actions are orientation, differentiation, balance, reaction, and rhythm. According to Gallahue and Ozmun (1995), coordinated movements are rhythmical and include the temporal sequencing of events and synchronizing of actions.

A growing body of literature indicates the role and importance of rhythm in tennis. According to Bourquin (2003), the role of rhythm is important for the tennis players in order to obtain harmonious movements. In addition, Segal (2005) claimed that, in professional tennis good rhythm includes the capabilities of perfect control during the impact, successful observation of the ball movements, effortless transmission on the ball and good timing. Supportively, Zachopoulou et al. (2000) asserted that execution of motor skills in tennis require movement synchronization with an external stimulus which is the ball trajectory. Schönborn (2003) stated that rhythmic stroke production must be included for tennis training. Furthermore, tennis players have some tactics that are used to demolish the rhythm of opponents by performing moon balls, slowing the ball speed and serving to unready players (Bourquin, 2003). In tennis, almost all players have their own rhythmic patterns or pre-performance rituals, just before their groundstroke, volleys or serve actions. According to Magill (2004), pre-performance rituals have effects on performance through stabilizing the motor control system.

## 1.1 The Purpose of the Study

The purposes of the study were to compare the effects of tennis specific and general rhythm training on the forehand consistency performance, rhythmic competence, tennis playing level and agility performance, and to examine the effects of different tempos on rhythmic competence of tennis players.

## 1.2 The Hypotheses

The purpose of the study was to test the following hypotheses:

1) Participants in the Rhythm Training Groups (GRTG and TRTG) were expected to exhibit higher improvement scores (pretest to posttest) than participants in the Tennis Group on:

a) Forehand consistency performance
b) Rhythmic competence
c) Tennis playing level
d) Agility performance

2) Participants in the TRTG were expected to exhibit higher improvement scores (pretest to posttest) than participants in the GRTG on:

a) Forehand consistency performance

b) Rhythmic competence

c) Tennis playing level

d) Agility performance

3) Shorter and longer time intervals of tempo were expected to differentiate rhythmic competence scores of participants.

## 1.3 Operational Definition

*Rhythm*: Rhythm is a formed pattern, usually of sounds or movements, with elements that are organized in duration and intensity; a serial recurrence that is balanced and harmonic, and repeated in regular groupings (Anshel et al., 1991).

*Rhythmic Competence:* Rhythmic competence is the ability to feel and express beat and the ability to move with others to a common beat (Weikart, 1989).

*Forehand Consistency Performance*: Forehand consistency performance is adjusting the rhythm of body movement and the rhythm of forehand stroke performance in the trajectory and bouncing rhythm (Zachopoulou & Mantis, 2001).

*Agility:* Agility is the physical ability which enables an individual to rapidly change positions and direction in a precise manner (Kriese, 1997).

*Tennis Playing Level:* Tennis playing level refers to the playing standard of a tennis player.

*Rhythmic Movement*: Rhythmic movement refers to sequences or patterns of body movement that combine elements of time and space (Weikart, 1989).

*Tennis-Specific Rhythm Training*: Tennis-specific rhythm training refers to the rhythm training including synchronization between movements specific to tennis and the external stimulus (metronome beats).

*General Rhythm Training*: General rhythm training is the training of the fundamental locomotor and nonlocomotor skills through synchronization of these skills with the external stimulus (metronome beats).

*Groundstroke*: Groundstroke is the shot when a tennis player hits the ball after the bounce (Sadzeck, 2001).

*Fast Tempo:* Fast tempo refers to the shorter time intervals between two sequential beats of metronome.

*Slow Tempo:* Slow tempo refers to the longer time intervals between two sequential beats of metronome.

*Split-Step*: Split-step refers to the slight jump that a player takes as an opponent is making contact with ball (Sadzeck, 2001).

## 1.4 Assumptions of the Study

The following assumptions have been determined in this study:

1) It is assumed that all participants possess normal physical abilities.

2) It is also assumed that the participants in all groups followed the instructions determined by the researcher at the beginning of the tests.

## 1.5 Limitations of the Study

The study was restricted by the following limitations:

1) The study was limited by sample size (n=30).

2) The study was limited to university students with a mean age of 23.1±2.3 (range 20 to 27) years.

3) The generalization of the results of this study was limited to tennis players.

4) Daily activities of the participants were not controlled.

## 1.6 Significance of the Study

The nature of tennis game provides opportunity for players to get acquainted with different rhythmic movements. These movements can be observed from their pre-performance rituals, footwork and strokes. This experimental study aimed to give an answer to the research question whether adding rhythmic exercises to the regular tennis training will enhance rhythmic competence. Moreover, the study attempted to raise information on the effects of rhythm training on forehand consistency performance, tennis playing level and agility performance.

Furthermore, the study also attempted to achieve a new rhythmic training approach by developing a new training system that can be used by coaches, physical education teachers and other tennis related staff.

## CHAPTER II

## REVIEW OF LITERATURE

According to Schönborn (2003), rhythm is the dynamic grouping, structuring and accentuation of sequential elements of a process, whose arrangement is determined by a required and/ or personally selected temporal scheme (Figure 1).

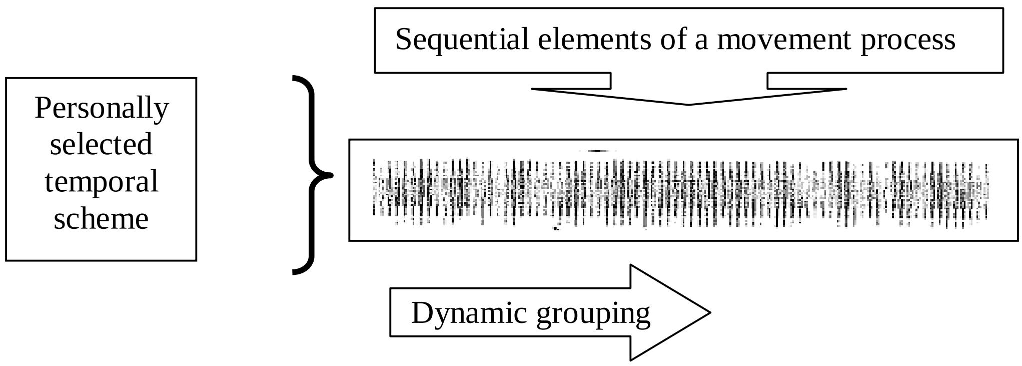


*Figure 1.* Graphical Representation of Rhythm.
Source: Schönborn, R. (2003). Timing in tennis: New findings and conclusions. In M. Crespo, M. Reid & D. Miley (Eds.), *Applied sport science for high performance tennis* (p. 37). The International Tennis Federation, ITF Ltd.

The role of rhythm can be observed in everyday living through understanding its functions, such as respiration and circulation, and in automatic motor activities, such as walking (Jackson, Treharne & Boucher, 1997). On the other hand, it was reported that development of rhythmic ability has not been researched extensively in physical education literature where the necessity for rhythmic accuracy has been recognized (Zachopoulou et al., 2003). According to Jalics et al., (1999), since walking, running, and dancing movements are inherently rhythmic, investigation of rhythmic movements is crucial to comprehend how body controls these movements.

Mor and Lev-Tov (2007) reported that a network of spinal neurons known as Central Pattern Generators (CPG) are responsible to produce the rhythmic motor patterns needed for coordinated swimming, walking, and running in mammals. Schmidt and Wrisberg (2004) defined CPG as a centrally located control mechanism which is established in the brain stem or in the spinal cord. In another recent paper, Zehr (2005) studied neural control of rhythmic human movement and stated that interneurons of CPG generate the pattern or locomotor drive to motoneurons, therefore it gives rise to rhythmic movement.

Zehr (2005) reported that the control of human rhythmic movement is depended on the interrelated communication among brain, spinal and sensory feedback. The rhythmic movement can be initiated by the supraspinal commands or by the peripheral feedback from the moving limps which in turn trigger the CPG networks (Zehr, 2005).

According to Schmidt and Lee (2005), the spinal cord can be able to produce a rhythm which can be present even without an input from the brain or higher centers, and without feedback from the limbs. However, to generate appropriate patterns of muscle activity across all joints and in all muscles, peripheral feedback is used for motor sculpting by interneurons involved in afferent pathways (Zehr, 2005).

In order to control rhythmic movements, the CPG produce a rhythm that results in alternating activation of antagonistic muscles (Enoka, 2002). Schmidt and Lee (2005) pointed out that interneurons within the spinal cord alternately stimulate the flexor and extensor motor neurons in a pattern. This network mechanism was schematically explained by the previous investigators (Schmidt & Wrisberg, 2004) (Figure 2). It was reported that a chemical or electrical signal (input signal) initiates a cyclical pattern of excitatory motor neural activity (Schmidt & Lee, 2005). The input signal activates neuron 1, which activates neuron 2, as well as the flexor muscles. Neuron 2 activates neuron 3, which activates neuron 4, as well as the extensor muscles. Neuron 4 activates neuron 1 again, and the process continues to repeat itself (Schmidt & Wrisberg, 2004).

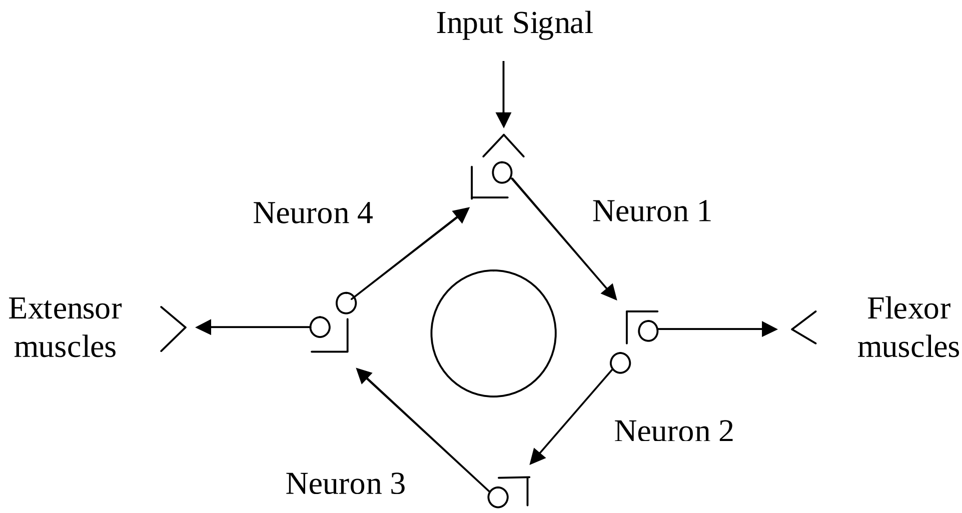


*Figure 2.* Interneurons Forming a Central Pattern Generator.
Source: Schmidt, R.A. & Wrisberg, C.A. (2004). *Motor learning and performance: A problem-based learning approach* (2nd ed.). Human Kinetics, Champaign, IL.

According to Weikart (1989), rhythmic movement refers to sequences or patterns of body movement that combine elements of time and space. Within this definition rhythmic means a time relationship, extending from the simple matching of an external steady beat to sequencing more complex movements (Weikart, 1989).

Weikart defined rhythmic competency, an important component to successful rhythmic movement, as the ability to feel and express beat and the ability to move with others to a common beat. Weikart asserted that rhythmic competency (Figure 3) is achieved when an individual has basic timing (feeling and expressing beat) and beat coordination (moving with others to a common beat). The ability to feel and indicate with a simple movement (beat awareness) and the ability to walk to the steady beat while engaging in a weight-bearing movement (beat competency) are necessary to possess basic timing (Weikart, 1989).

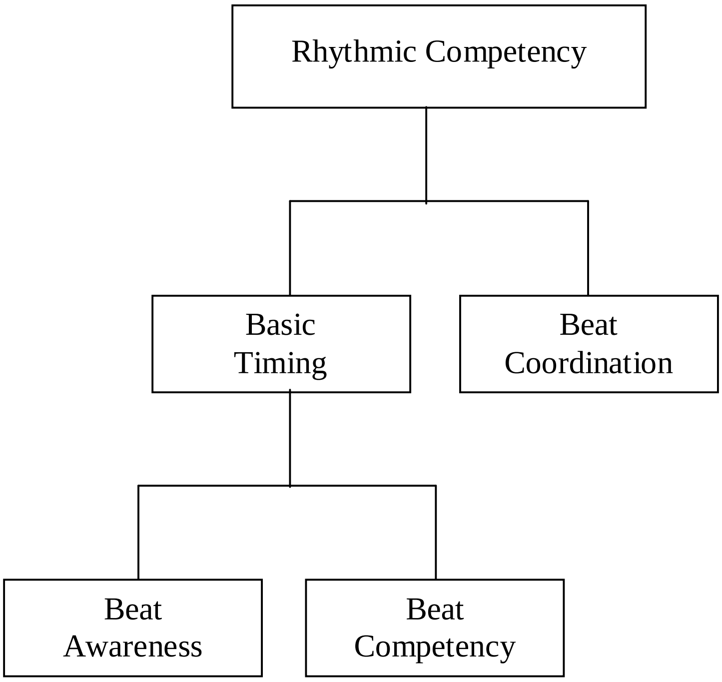


*Figure 3*. Schematic Explanation of Rhythmic Competency.
Source: Weikart, P. (1989). *Teaching movement and dance: A sequential approach to rhythmic movement* (p. 54). The High/Scope Press, Ypsilanti, MI.

It is still arguable whether the rhythmic ability is based on the function of an internal biological timer which is genetically programmed or is depended on the process of a specific type of information developed through experience (Zachopoulou et al., 2003). According to Weikart (1989), since the rhythmic ability is not naturally developed as individuals mature, children and adults, who lack the needed skills must participate progressively complex beat coordination activities to enhance their ability. On the other hand, Schleuter and Schleuter (1985) pointed out that the capability to perform accurate physical responses to rhythm patterns are influenced by maturation. Additionally, Rosenbusch and Gardner (1968) reported that age has effects on reproduction of rhythmic patterns. Smoll (1975) asserted that age has positive effects on development of the spatial and temporal elements of rhythmic activity. According to Zachopoulou et al. (2003), progression of children's rhythmic ability and other abilities depend on maturation of basic functions of the central nervous system and their stimulation with practice.

Pollatou, Karadimou, and Gerodimos (2005) studied gender differences in musical aptitude, rhythmic ability and motor performance in preschool children. Ninety-five preschool children, 50 girls and 45 boys, 5 to 6 years of age, participated in the study. Primary Measures of Music Audition, Rhythmic Competence Analysis Test (RCAT) and the Gross Motor Development tests were administered to the participants. Results revealed no significant gender differences in musical aptitude and gross motor skills performance. The only difference between boys and girls was reported in the rhythmic ability performance. It was concluded that rhythmic ability was strongly inter-related with children's motor coordination.

This result is in accord with findings of Schleuter and Schleuter (1985), Weikart (1989), and Haines (2003). They pointed out that sex is a differentiative factor for rhythmic ability and girls are more accure than boys. Weikart (1989) reported that practising activities like jumping rope and dancing creates more opportunities for girls to experience rhythmic movements in comparison with boys. However, this result contrasts with the findings of Groves (1969), Smoll (1975), Zachopoulou et al. (2000), and Söğüt and Kirazcı (2008) who stated that gender has no effect on rhythmic ability.

Another performance differentiating factor for the rhythmic competence performance is the frequency of tempo. According to Fraisse (1982), the possibility of rhythmic perception depends on tempo. The time interval between two beats of external stimulus (metronome beats), which can be short (fast tempo) or can be long (slow tempo), has an effect on successful synchronization. Previous studies (Ellis, 1992; Kumai & Sugai, 1997; Zachopoulou et al., 2000; Mastrokalou & Hatziharitos, 2007) reported that rhythmic ability was more precise at fast tempo than at slow tempo.

Rhythmic accuracy is also influenced by an individual's preferred tempo. Preferred tempo can be determined by asking which metronome tempo was considered most natural (Van Noorden & Moelants, 1999). Fraisse (1982) reported that preference for the preferred tempo is between 500 and 700 msec. According to Thomas and Moon (1976), an individual's rhythmic response to the given task can be controlled externally (performer is imposed to synchronize his/her movement to the externally paced stimuli) or internally (the initiation or the rate of the movement is determined by performer). Mastrokalou and Hatziharitos (2007) stated that rhythmic ability is more precise for the preferred tempo than it is under the imposed rhythmic stimuli.

Previous investigations also reported the correspondence between preferred tempo and periodic activity of heart (Fraisse, 1982; Iwanaga, 1995). Iwanaga (1995) examined the relationship between preferred tempo and heart rate of seven male and seven female subjects from the ages of 19 to 21 years. As a result, it was concluded that preferred tempo had a harmonic relation to heart rate of the participants.

Mori, Iteya, and Gabbard (2007) investigated hand preference consistency and simple rhythmic bimanual coordination in children. 27 preschool children, 4 to 6 years of age, determined as 10 right-handed, 8 left-handed, and 9 mixed-handed, were participated to the study. A bimanual taping task, design to assess auditory-hand coordination, was used to test motor coordination. As a consequence, right-handers were found more accurate than their left- and mixed-handed peers.

According to Weikart (1989) rhythmic movement activities can be practiced in four ways: Moving the body in nonlocomotor ways, moving the body in locomotor ways, moving the body in integrated ways, and moving with objects. Nonlocomotor skills comprised of movements of the body where one or more parts of the body maintain contact with the floor or apparatus while other parts of the body move in different directions, pathways, and levels (Kirchner & Fishburne, 1995). Weikart (1989) asserted that nonlocomotor movement may be performed with and without objects such as, bouncing, tossing, throwing a ball and swinging a tennis racket. On the other hand, locomotor skills are used to move the body from one place to another or to project the body upward, as in jumping and hopping (Pangrazi, 2007). Integrated movements, which can be performed with and without objects, are the purposeful combination of nonlocomotor upper body movement with locomotor lower-body movements. On the other hand, moving with objects can be trained by using an object in combination with nonlocomotor, locomotor, and integrated movement patterns (Weikart, 1989).

Weikart (1989) stated that development of rhythmic competency facilitates significant differences in at least three skill areas related to rhythmic movement: 1) motor skills, 2) musical skills, and 3) academic skills. Supportively, according to Chatzikonstantinou et al., (2008), rhythmic ability is one of the coordination abilities and its progression is related to motor skills improvement, academic achievement, dancing performance and sports. Campbell (1991) asserted that the rhythmic movements within the elementary school program create opportunities for children to develop their physical, social and cultural characteristics.

Previous studies indicated the positive effects of rhythm and rhythm training on academic achievement of children. Boyle (1970) conducted a study to analyze the effects of systematic rhythm training that includes marking the underlying beat synchronized with foot tapping and hand clapping which was used to practice rhythm patterns related to the beat, on capability of read music at sight. 191 junior high school students were participated in the study. As a result, it was claimed that rhythm training comprised of foot tapping to mark the underlying beat and hand clapping to train rhythmic pattern would enhance the performance of sight-reading.

David et al. (2007) conducted a longitudinal study to investigate the rhythm and reading development in school aged children. Initially, fifty-three children attended to the study in the fall of grade 1. 47, 44, and 38 children were retested respectively in the fall of grades 2–5. Phonological awareness, naming speed, reading ability, and rhythm ability were measured. RCAT was administered to evaluate the rhythmic ability of the participants. It was concluded that rhythm in grade 1 is significantly related not only to the two main predictors of reading ability, phonological awareness and naming speed but also to reading ability in the same year and up to 4 years later.

A study performed by Trump (1987) showed also the necessity of rhythm training in educational settings. The researcher studied the effects of rhythmic training on rhythmic competence in primary age children. 54 first graders were participated in the study. RCAT was used by investigator to measure initial and final rhythmic competence of the participants. It was concluded that, although maturation was important to the development of rhythmic competence, rhythmic training could also improve rhythmic competence performance.

Derri et al. (2001) studied on preschool children in order to investigate the effects of a music and movement program including the on progression of locomotor skills. The program consisted of movements which were connected to rhythm. Findings showed that developmental performance of the participants in the experimental group that were exposed to music and movement program, were higher than the participants in the control group who executed only in free play movement activities. As a result, it was concluded that movements associated with proper rhythmic patterns might be beneficial for progression of some basic motor skills like galloping, leaping, horizontal jump, and skipping.

Zachopoulou et al. (2003) investigated the effects of 10-week music and movement program on the level of rhythmic ability in children. Seventy-two preschool children (34 girls and 38 boys), 4 to 6 years of age participated in the study. RCAT was used to test the rhythmic ability of the participants with a steady metronome beat (100 beats per minute). The experimental group consisted of 34 children who participated in the music and movement program twice a week while the others who participated only in free-play activities constituted as control group. Findings indicated that rhythmic ability of the participants in the experimental group improved significantly more than the control group. Finally, it was concluded that the specific program can facilitate the development of the rhythmic ability in preschool children.

Rhythm and rhythm training also has been widely used by the practitioners to facilitate rehabilitation of same diseases. Thaut et al. (1996) reported that rhythmic auditory stimulation (RAS) has positive effects on gait velocity, rhythm, and stride length of Parkinson's disease patients. In addition, Hausdorff et al. (2007) pointed out that RAS can enhance progression of gait speed, stride length and swing time of Parkinson's disease patients. Furthermore, Kwak (2007) asserted that RAS improves gait performance of children with spastic cerebral palsy.

Studies, proving the importance of the rhythm in sports skill, extends many fields. Laurence (2000) conducted a study related with the role of rhythm in ballet training and stated that there are specific rhythmic abilities associated with ballet training. It was also reported that rhythm is an integral part of ballet training and that there are rhythmic abilities which are conducive to success in ballet.

Zachopoulou, Tsapakidou, and Derri, (2004) investigated effects of developmentally appropriate music and movement program on the development of jumping and dynamic balance in children. Ninety children, 42 girls and 48 boys, 4 to 6 years of age, participated in the study. The participants were randomly distributed to experimental and control groups. The experimental group followed the music and movement program for two months. During this period the control group followed their regular physical education program. The results indicated that both jumping and dynamic balance of the participants in the experimental group improved significantly more than the control group. Consequently, it was reported that developmentally appropriate music and movement program, based on rhythmic education, has positive effects on jumping and dynamic balance of preschool children.

Crust and Clough (2006) studied on physically active participants (mean age=22.3 ± 6.4 years) in order to examine the effects of motivational asynchronous music on the endurance performance of participants performing a non-complex, isometric muscular-endurance task (holding 1.1. kg dumbbell at a 90$^{o}$ angle consistently), with special focus on determining the relative contribution of rhythm to any response. Participants were randomly assigned to experimental trials under three conditions: (1) no music, (2) rhythm and (3) music. The same selected song was used for the rhythm and music conditions despite the rhythm condition included no melody, harmonies or lyrics. Findings indicated that the performances of participants were better when exposed to music than rhythm and also they perform better when exposed to rhythm condition than no music.

Söğüt and Kirazcı (2008) examined the effects of sport participation and gender on rhythmic ability. Participants were junior competitive male and female tennis players (n=31, mean age=11,61 year, mean tennis training age=4,38 year) and non-active male and female controls (n=32, mean age=12,12 year). The High/Scope Rhythmic Competence Analysis Test (RCAT) was used to evaluate the rhythmic competence of participants. RCAT was conducted with two different tempos of metronome which were 50 beats per minutes and 120 beats per minutes. The scale which was extending from 1 to 3 was used by the observers. The 3 point was used for the movements that have accurate synchronization, the 2 point was used for the movements nearby to synchronization, and the 1 point was used for the unsynchronized movements. Results revealed that mean rhythmic competence score of the junior competitive tennis players was significantly higher than the non-active controls for both slow (tennis players=1.39, SD=0.32; controls=1.24, SD=0.21) and fast (tennis players=1.52, SD=0.38; controls=1.34, SD=0.28) tempos.

The study was mostly triggered by the interesting findings of experiments that were conducted during the last decade. The first one (Zachopoulou et al., 2000) investigated rhythmic ability of 50 tennis players (mean age=9.5±5.2 years old), 53 basketball players (mean age=9.8±6.3 years old), 52 swimmers (mean age=9.2±4.2 years old), and 52 controls. Children in the sport groups were found more accurate than the controls when rhythmic ability considered. Additionally, rhythmic ability test scores of tennis players were found more accurate than the other three groups. It was claimed that all movements in tennis require distinct rhythmic structures and practicing these movements create opportunities for rhythmic actions through experiencing different tempos of rhythm.

The latter (Zachopoulou and Mantis, 2001) examined the effects of rhythm training on rhythmic ability and forehand stability performance of tennis players. 8–10 year old fifty tennis players (23 girls and 27 boys) participated in the study. The 10-week rhythm training was performed by the participants. The forehand groundstroke stability performance and the rhythmic ability of participants were measured before and after training protocol. Eventually, it was concluded that participation to the rhythm training caused progression in rhythmic ability and in the forehand stability performance of tennis players.

# CHAPTER III

# METHOD

The purpose of the study were; to compare the effects of tennis specific and general rhythm training on the forehand consistency performance, rhythmic competence, tennis playing level and agility performance, and to examine the effects of different tempos on rhythmic competence of tennis players. It was hypothesized that participants in the rhythm training groups (GRTG and TRTG) were expected to exhibit higher improvement scores (pretest to posttest) than the participants in the Tennis Group. In addition, participants in the TRTG were expected to exhibit higher improvement scores than participants in the GRTG. Further, shorter and longer time intervals of tempo were expected to differentiate rhythmic competence scores of participants.

## 3.1. Subjects

Thirty university students (15 male & 15 female) whose tennis training duration was between 2 to 42 months volunteered for this study. The age range was between 20 to 27 years. Their mean International Tennis Number (ITN) was 7.3 (SD=0.9). Players at this level are fairly consistent while hitting the medium paced shots, but are not yet comfortable with all strokes (Crespo, Reid & Miley, 2003). All participants were informed on the nature and purpose of the study both verbally and in the written form. The informed consent form was signed by all participants (Appendix A). Table 1 represented participants' descriptive statistics.

Table 1

Descriptive Statistics of the Participants' Age, International Tennis Number and Tennis Training Age.

| Parameters | Age (year) | | ITN | | TTA (month) | |
|---|---|---|---|---|---|---|
| | M | SD | M | SD | M | SD |
| Scores | 23.1 | 2.3 | 7.3 | 0.9 | 12.8 | 12.3 |

Note. ITN=International Tennis Number, TTA=Tennis Training Age

3.2. Apparatus and Task

The International Tennis Number (ITN), represents a tennis player's general level of play, that was used to determine the tennis playing level of the participants. Under this system, players are rated from ITN 1 to ITN 10. ITN 1 represents a high level play (holding an ATP / WTA ranking or of an equivalent playing standart) and ITN 10 is a player who is new to the game. The ITN has been approved by the International Tennis Federation (ITF) Coaches Commission and the ITF International Tennis Rating Taskforce (Crespo, Reid & Miley, 2003). The participants performed totally 42 strokes (Appendix B) by applying their basic techniques of tennis (forehand, backhand, volley, serve). The ITN includes;

1) Groundstroke depth assessment (10 alternate forehand and backhand groundstroke),

2) Groundstroke accuracy assessment (6 alternate forehand and backhand down the line and 6 alternate forehand and backhand cross court),

3) Volley depth assessment (8 alternate forehand and backhand volleys),

4) Serve assessment (12 serves in total, 3 serves in each target area), and

5) Agility test.

The Spider Test (Figure 4) which is included within ITN test was used to evaluate the participants' agility performances. "This assessment measures the time it takes a player to pick up five tennis balls and return them individually to a specific zone" (Crespo, Reid & Miley, 2003, p.173 ).

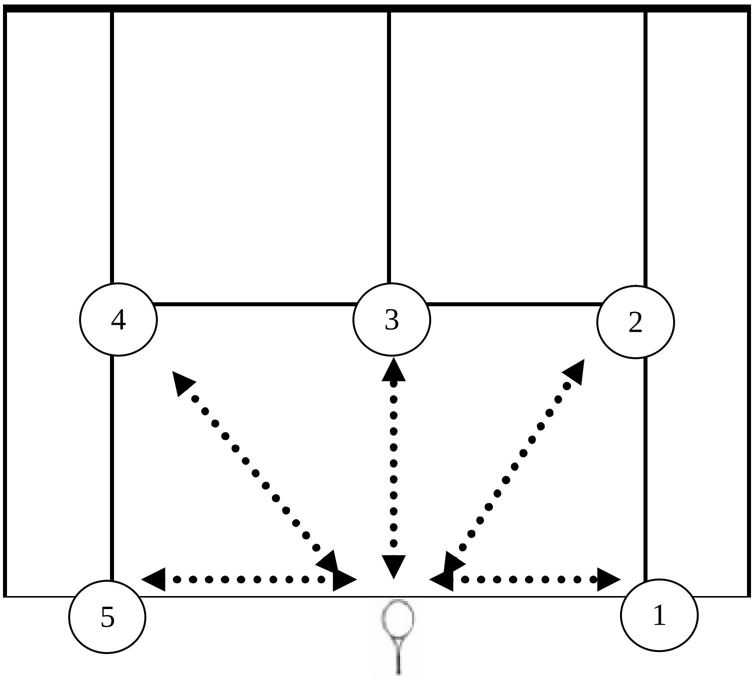


*Figure 4*. Spider Test

Source: Crespo, M., Reid, M. & Miley, D. (2003). *Applied sport science for high performance tennis*. The International Tennis Federation, ITF Ltd.

The Spider Test was conducted according to the procedure reported by Roetert et al. (1996). The test was conducted by placing 5 tennis balls on the court: one on each corner where the singles sidelines and service line meet, and one ball on the T. The participants were asked to start at the center of the baseline, retrieve each ball and place it on the strings of a racket, one ball at a time in a counterclockwise direction. The time was recorded with a stopwatch after the command “Ready-set-go” is given. As soon as the last ball was placed on the strings of racket, the time was stopped. The test was applied twice and the best score was recorded.

The High/ Scope Rhythmic Competence Analysis Test (RCAT) was used (Weikart, 1989) to evaluate rhythmic competence of participants for both tempos of 50 and 100 beats per minutes (bpm). Weikart (1989) designed RCAT, which includes nonweight-bearing movement seated and weight-bearing movement, standing and walking, in order to evaluate an individual’s beat competency by testing his/her ability to perform a movement task to the underlying steady beat. A Rhythm Watch

Device (TAMA RHYTHM WATCH, RW 105, weight=330 g including battery, size=127 x 25 x 151 mm) was used for all tests and training procedures to arrange the tempos. The tempo range of device (Figure 5) is between 30 and 250 bpm.


*Figure 5*. Tama Rhythm Watch Device
Source: http://www.tamadrum.co.jp/usa/products/accessories/RW105.html

RCAT was administered in a silent room and with two different tempos of metronome which was 50 and 100 bpm. The participants were tested individually after they had been familiarized with the nature of tasks and the testing environment. For the analysis of performance in RCAT, the scores were videotaped. Each participant was asked to synchronize a series of six movements for six times and totally 36 movements were analyzed by the observers. The mean scores for each task were determined by averaging the scores of the two observers. The movements were;

1) Patting the thighs with both hands at the same time,
2) Patting the thighs alternating the hands for each pat,
3) Walking the beat while still seated,
4) Walking the beat in one place,
5) Walking forward direction, and
6) Walking backward direction.

Two observers independently scored videotaped tests for each movement. They used the scale which was extending from 1 to 3. The 3 point was used for the movements that have accurate synchronization, the 2 point was used for the movements nearby to synchronization, and the 1 point was used for the non-synchronized movements (Appendix C).

In order to evaluate intra-observer agreement two observers observed videotaped RCAT performance of 10 participants for each tempos. Furthermore, to evaluate the inter-observer agreement the same observer observed videotaped RCAT performance of 10 participants twice at two different times. Observer agreement analysis for RCAT was calculated according to the following formula (Van Der Mars, 1989):

$$\text{Percentage of agreements} = \frac{\text{Number of agreements}}{\text{Number of agreements + Disagreements}} \times 100$$

Results of observer agreements for RCAT were given in Table 2.

Table 2

Inter-Observer and Intra-Observer Agreement for Scores in RCAT

| Tempo | Intra-observer agreement | Inter-observer agreement |
|---|---|---|
| 50 bpm | 77% | 75% |
| 100 bpm | 79% | 76% |

Note. bpm=beat per minute

The Untimed Consecutive Rally Test (UCRT) was used (Sherman, 1972), to analyse forehand consistency performance of participants. The test reliability was .88 and the concurrent validity coefficient was .60. The testing area of UCRT (Figure 6) was arranged with regard to instruction designed by Sherman (1972). A backboard or a smooth wall surface at least 3.03 m high and 6.09 m wide and a court or floor area was required which extended outward from the board at least 9.14 m. A net line running parallel to the floor was located on the board 0.91 m above the floor area. A 2.13-m by 5.48-m target was placed on the board. It extended 2.13 m above the net line and was 5.48 m wide. A restraining line was located on the floor 6.40 m from the board and parallel to it.

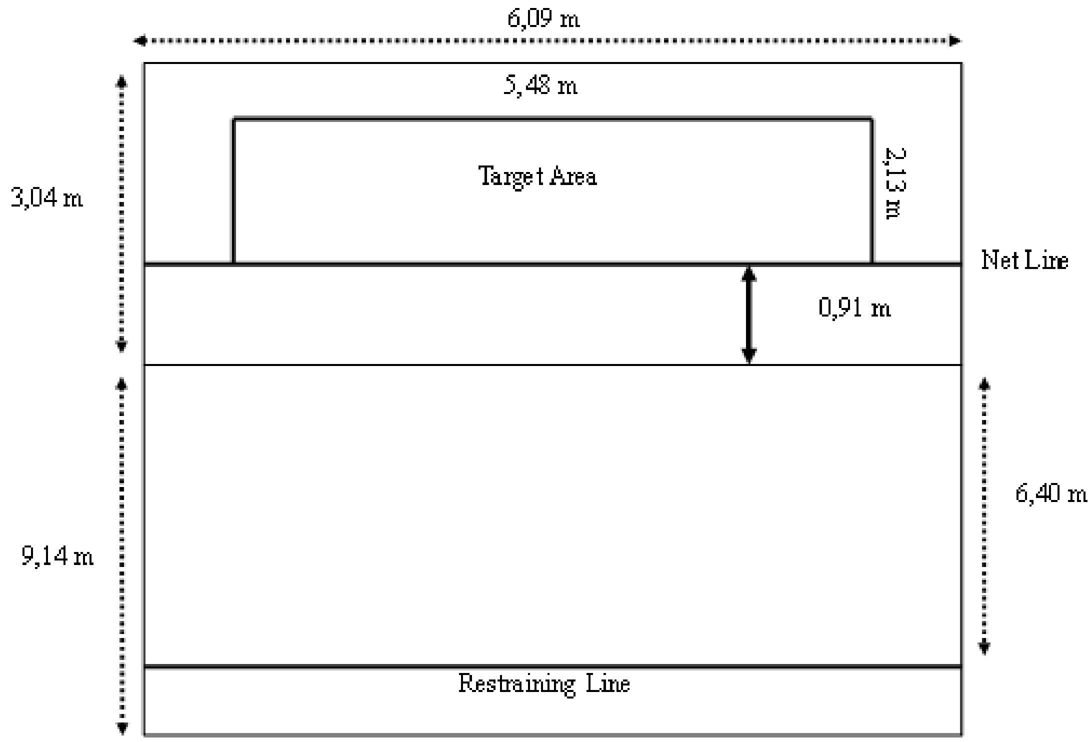


*Figure 6*. Diagram of the Testing Area for the Untimed Consecutive Rally Test.
Source: Sherman, P.A. (1972). *A selected battery of tennis skill tests*. Unpublished Doctoral Dissertation, University of Iowa.

UCRT was administered according to the procedure reported by Sherman (1972). In the UCRT, each participant was allowed one warm-up trial. All participants in each group were to take their warm-up trial prior to the beginning of the first test trial. Each participant attempted to achieve the greatest number of consecutive rallies into the target for each trial. In starting the ball for the rally, the participant dropped the ball and hit it on the first bounce into the target area. All balls were to be contacted on or prior to the first bounce throughout the consecutive rally. Each participant had a total of three trials which were recorded. All participants in a group were to finish the first trial before the second trial was taken. Failure to accomplish the following ended the consecutive rally;

1) To rally or volley the ball into the designated target area,

2) To contact the ball on the first bounce when starting the rally,

3) To contact the ball on the first bounce or prior to the bounce throughout the consecutive rally, and

4) To have at least one foot behind the restraining line.

The score for each trial was the number of consecutive good rallies. The final score for the test was the mean of three trials.

Zachopoulou and Mantis (2001) applied the UCRT by proposing a new version in order to analyze the effects of rhythm training on rhythmic competence and forehand consistency of tennis players. The researchers conducted UCRT for two distances from the wall that were 2 and 3 meters. This version of UCRT was preferred because of the needs and specificity of present study. This procedure was followed for each distance from the training wall. The test was applied at the distances of 2 m (Figure 7 a) and 3 m (Figure 7 b) from the training wall.

a b

*Figure 7*. Forehand Consistency Tests a) 2 m b) 3 m (Photographs by Author)

3.3. Procedure and Design

The participants were tested on a one by one basis and all tests comprised of practice trials. Each participant was pretested in the following tests order:

International Tennis Number (ITN), Agility Test (AT), Rhythmic Competence Analysis Test (RCAT) and Untimed Consecutive Rally Test (UCRT). Participants were randomly assigned into one of the experiment groups: Tennis Group (TG), General Rhythm Training Group (GRTG), and Tennis-specific Rhythm Training Group (TRTG). In addition, in order to prevent gender effects, male and female participants were equally distributed to the groups. Each group consisted of 5 male and 5 female participants. The experimental procedure lasted for 8 weeks. During this period, all groups had the same tennis training two times per week. The TG continued only regular tennis training sessions. The GRTG followed the general rhythm training sessions in addition to their regular tennis training, two times per week for 15 minutes at the beginning of their training sessions. The TRTG had additional tennis-specific rhythm training two times per week for 15 minutes at the beginning of the regular tennis training sessions. For the diagnostic purposes the midtest was applied after four week had been completed. Eventually, the final measurements were performed after 8-week training protocol was completed.

#### 3.3.1. Training Procedures

##### 3.3.1.1. Tennis Training

All groups had the same tennis training program two times per week for one hour and fifteen minutes. Each session started with general and sport-specific warm-up and continued with practicing basic tennis strokes (forehand and backhand groundstrokes, forehand and backhand volleys, and serve).

##### 3.3.1.2. Rhythm Trainings

A pilot testing was administered to determine the appropriate tempos of rhythmic movements for the rhythm trainings. It was observed that synchronization between rhythmic movements and the steady beat of metronome became easier when the tempo was higher. Therefore, the range of tempo for the tennis-specific and general rhythm training was decreased gradually from faster to slower. Additionally, because of the nature of some exercises, such as bouncing tennis ball with hand and racket, the tennis-specific rhythm training was performed with two different ranges of tempo which were fast and slow. The slow tempos were between 45 and 55 bpm and the fast ones were between 80 and 120 bpm. These ranges of tempos were also set for the rhythmic movements for general rhythm training as parallel to tennis-specific rhythm training. All training sessions were started with slow movements and continued with fast movements. Table 3 gives the information about the gradual progression of the tempos for rhythm trainings.

Table 3

Training Progression Table for the Tempos of Rhythm Trainings

| Slow Movements | | Fast Movements | |
|---|---|---|---|
| Week | Tempo | Week | Tempo |
| 1-2 | 55 | 1-2 | 120 |
| 3-5 | 50 | 3-5 | 100 |
| 6-8 | 45 | 6-8 | 80 |

3.3.1.2.1. General Rhythm Training

The general rhythm training (Table 4) was performed only by the GRTG for eight weeks. The general rhythm training was administered before tennis training and conducted twice a week for fifteen minutes. The program included some locomotor and nonlocomotor movements which were synchronized with the beats of metronome. The rhythmic movements for general rhythm training program are given in Appendix D.

Table 4

Rhythmic Movements for General Rhythm Training

| **Slow Movements (45-55 bpm range)** | **Duration (minute)** |
|---|---|
| Side Jumping | 1.5 |
| Hand Clapping | 2 |
| Front and Back Jumping | 1.5 |
| Walking In Place | 2 |
| **Fast Movements (80-120 bpm range)** | **Duration (minute)** |
| Hand Clapping | 2 |
| Side Walking | 2 |
| Walking Forward and Backward | 4 |

3.3.1.2.2. Tennis-Specific Rhythm Training

The tennis-specific rhythm training consisted of some tennis-specific movements (Table 5) which were synchronized with the beats of metronome and performed by the TRTG for eight weeks. The training was administered before tennis training and conducted twice a week for fifteen minutes. The rhythmic movements for tennis-specific rhythm training program are given in Appendix E.

Table 5

Rhythmic Movements for Tennis-Specific Rhythm Training

| **Slow Movements (45-55 bpm range)** | **Duration (minute)** |
|---|---|
| Bouncing tennis balls with both hands at the same time | 1 |
| Bouncing balls by alternating hands | 1 |
| Bouncing balls with both hands at the same time while walking | 1 |
| Bouncing balls by alternating hands while walking | 1 |
| Bouncing the ball by forehand and backhand groundstroke with racket | 2 |
| **Fast Movements (80-120 bpm range)** | **Duration (minute)** |
| Performing forehand and backhand strokes, in four phases, without hitting the ball | 3 |
| Bouncing the ball by forehand and backhand volley synchronized with metronome beats | 2 |
| Performing ground strokes, without hitting ball, by applying synchronized steps with metronome beats | 4 |

3.4. Statistics

Parametric tests were initially supposed to be used in the analysis of the research data. However, the non-parametric tests were conducted for the rest of statistical process, since the Homogeneity of Variance assumption of One-Way ANOVA was violated. Therefore, the Kruskal-Wallis Test, which is the non-parametric equivalent of One Way ANOVA, was used to calculate the possible differences between initial scores and also to compare the improvement scores of groups. Afterwards, Wilcoxon Test was used to examine the differences between initial, mid, and final test scores within each group. Finally, Mann-Whitney U Test was conducted to determine the pairwise comparisons of groups for improvement scores and to analyze the rhythmic competence scores of participants for different tempos.

# CHAPTER IV

# RESULTS

The independent variables of the study consisted of regular tennis training, general rhythm training, and tennis-specific rhythm training. The dependent variables of the study were forehand consistency performance (for two distances), rhythmic competence (for two tempos), tennis playing level, and agility performance.

## 4.1. Descriptive Data for Test Results

The descriptive statistics for the pretest, midtest, and posttest scores of groups (Figure 8) for International Tennis Number (ITN) were presented in Table 6. Results indicated that the ITN test scores of all groups improved from pretest to posttest.

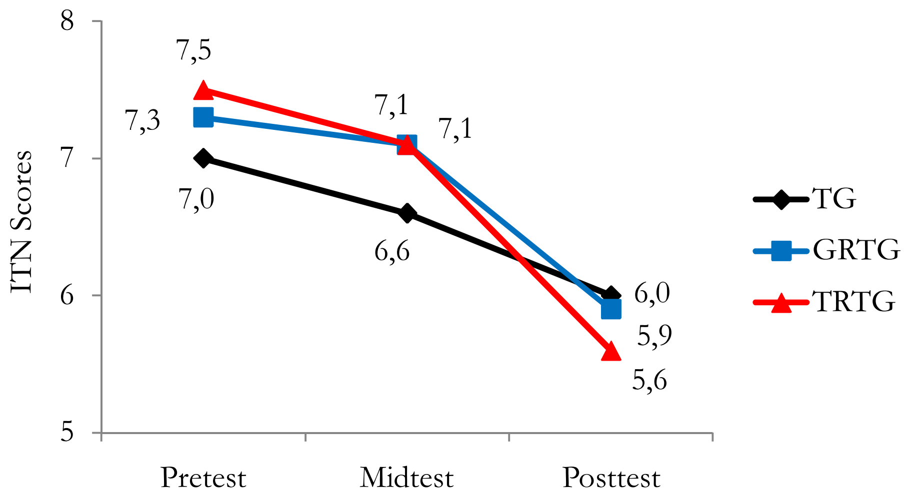


*Figure 8.* Pretest, Midtest, and Posttest Scores for ITN

Table 6

Descriptive Statistics of Groups for Pretest, Midtest, and Posttest Scores for ITN

| Group / | Pretest | | Midtest | | Posttest | |
|---|---|---|---|---|---|---|
| ITN | *M* | SD | *M* | SD | *M* | SD |
| TG | 7.0 | 0.8 | 6.6 | 1.1 | 6.0 | 0.7 |
| GRTG | 7.3 | 1.0 | 7.1 | 0.9 | 5.9 | 0.7 |
| TRTG | 7.5 | 0.9 | 7.1 | 0.9 | 5.6 | 0.5 |

The descriptive statistics for the pretest, midtest, and posttest scores of groups (Figure 9) for Untimed Consecutive Rally Test (UCRT) for 2m were presented in Table 7. Results showed that forehand consistency (2m) test scores of all groups advanced from pretest to posttest. Besides, participants in the TRTG had higher improvement scores than the participants in the other two groups.

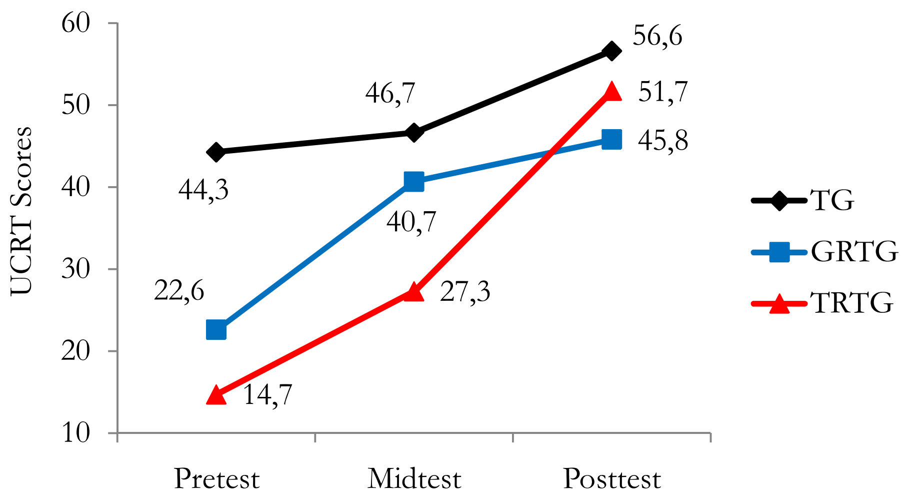


*Figure 9.* Pretest, Midtest, and Posttest Scores for UCRT (2m)

Table 7

Descriptive Statistics of Groups for Pretest, Midtest, and Posttest Scores for UCRT (2m)

| Group / | Pretest | | Midtest | | Posttest | |
|---|---|---|---|---|---|---|
| UCRT (2m) | *M* | SD | *M* | SD | *M* | SD |
| TG | 44.3 | 51.3 | 46.7 | 43,1 | 56.6 | 45.3 |
| GRTG | 22.6 | 23.9 | 40.7 | 54.6 | 45.8 | 38.5 |
| TRTG | 14.7 | 12.2 | 27.3 | 18.1 | 51.7 | 32.5 |

The descriptive statistics for the pretest, midtest, and posttest scores of groups (Figure 10) for Untimed Consecutive Rally Test (UCRT) for 3m were presented in Table 8. Results demonstrated that the forehand consistency (3m) test scores of all groups increased from pretest to posttest. Furthermore, participants in the rhythm training groups (GRTG and TRTG) had higher improvement scores than participants in the TG.

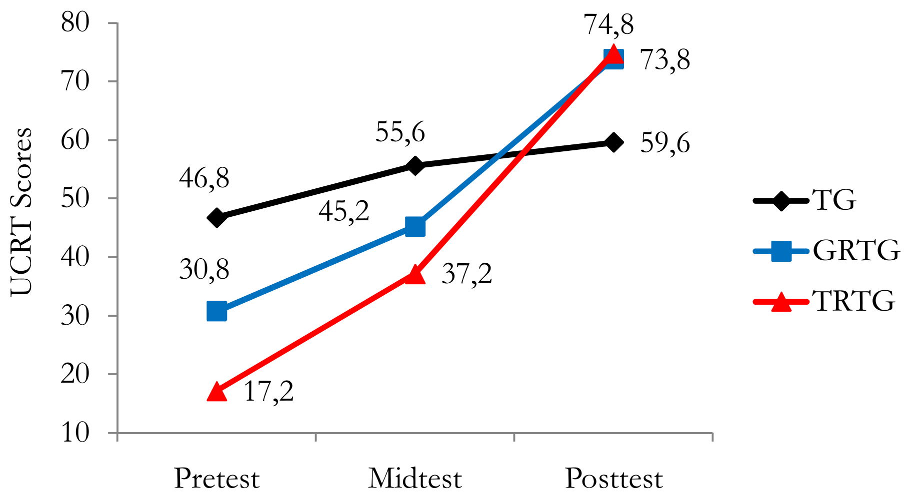


*Figure 10.* Pretest, Midtest, and Posttest Scores for UCRT (3m)

Table 8

Descriptive Statistics of Groups for Pretest, Midtest, and Posttest Scores for UCRT (3m)

| Group / | Pretest | | Midtest | | Posttest | |
|---|---|---|---|---|---|---|
| UCRT (3m) | *M* | SD | *M* | SD | *M* | SD |
| TG | 46.8 | 41.6 | 55.6 | 48.9 | 59.6 | 36.8 |
| GRTG | 30.8 | 34.8 | 45.2 | 32.6 | 73.8 | 66.9 |
| TRTG | 17.2 | 10.8 | 37.2 | 26.8 | 74.8 | 43.9 |

The descriptive statistics for the pretest, midtest, and posttest scores of groups (Figure 11) for Rhythmic Competence Analysis Test (RCAT) for 50 bpm were presented in Table 9. Results showed that the rhythmic competence (50 bpm) test scores of all groups improved from pretest to posttest. In addition, participants in the rhythm training groups (GRTG and TRTG) had higher improvement scores than participants in the TG.

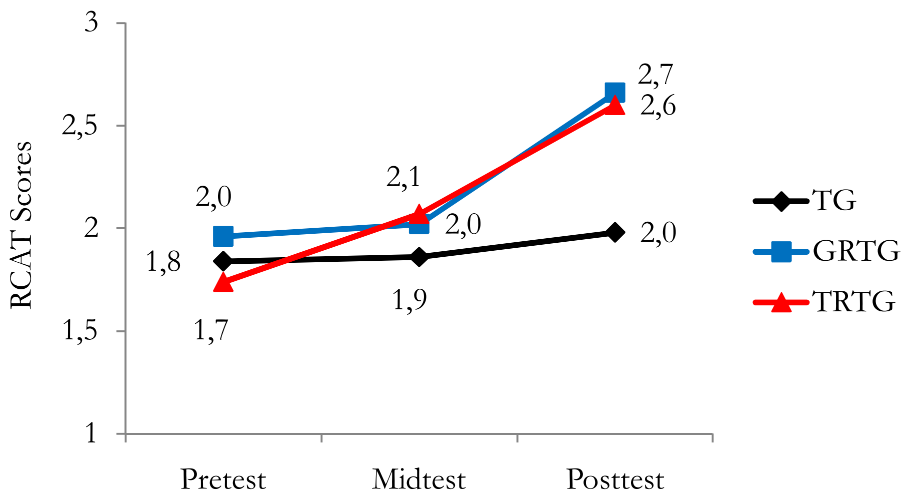


*Figure 11*. Pretest, Midtest, and Posttest Scores for RCAT (50 bpm)

Table 9

Descriptive Statistics of Groups for Pretest, Midtest, and Posttest Scores for RCAT (50 bpm)

| Group / RCAT (50 bpm) | Pretest | | Midtest | | Posttest | |
|---|---|---|---|---|---|---|
| | *M* | SD | *M* | SD | *M* | SD |
| TG | 1.8 | 0.3 | 1.9 | 0.4 | 2.0 | 0.2 |
| GRTG | 2.0 | 0.5 | 2.0 | 0.4 | 2.7 | 0.3 |
| TRTG | 1.7 | 0.4 | 2.1 | 0.5 | 2.6 | 0.2 |

The descriptive statistics for the pretest, midtest, and posttest scores of groups (Figure 12) for Rhythmic Competence Analysis Test (RCAT) for 100 bpm were presented in Table 10. Results indicated that the rhythmic competence (100 bpm) test scores of all groups improved from pretest to posttest.

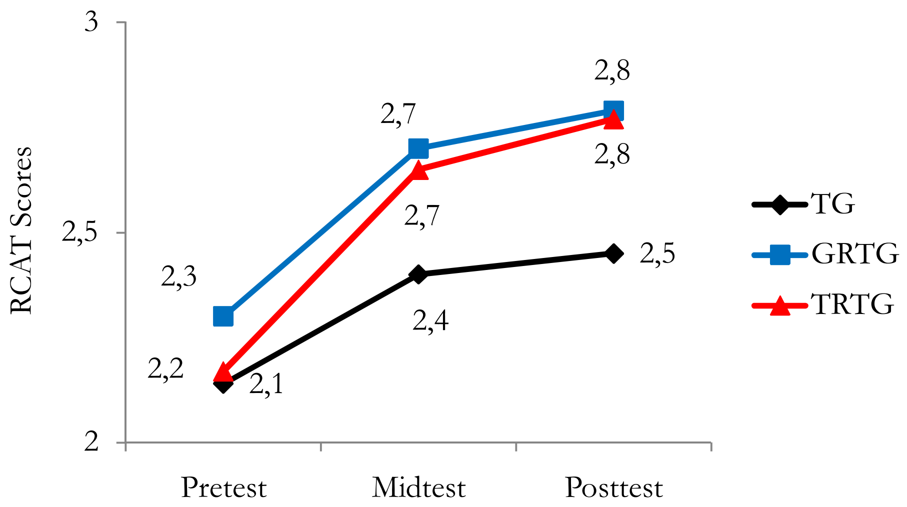


*Figure 12.* Pretest, Midtest, and Posttest Scores for RCAT (100 bpm)

Table 10

Descriptive Statistics of Groups for Pretest, Midtest, and Posttest Scores for RCAT (100 bpm)

| Group / RCAT (100 bpm) | Pretest | | Midtest | | Posttest | |
|---|---|---|---|---|---|---|
| | *M* | SD | *M* | SD | *M* | SD |
| TG | 2.1 | 0.5 | 2.4 | 0.4 | 2.5 | 0.6 |
| GRTG | 2.3 | 0.3 | 2.7 | 0.3 | 2.8 | 0.2 |
| TRTG | 2.2 | 0.6 | 2.7 | 0.3 | 2.8 | 0.2 |

The descriptive statistics for the pretest, midtest, and posttest scores of groups (Figure 13) for Agility Test (AT) were presented in Table 11. Results demonstrated that the agility performances of all groups advanced from pretest to posttest.

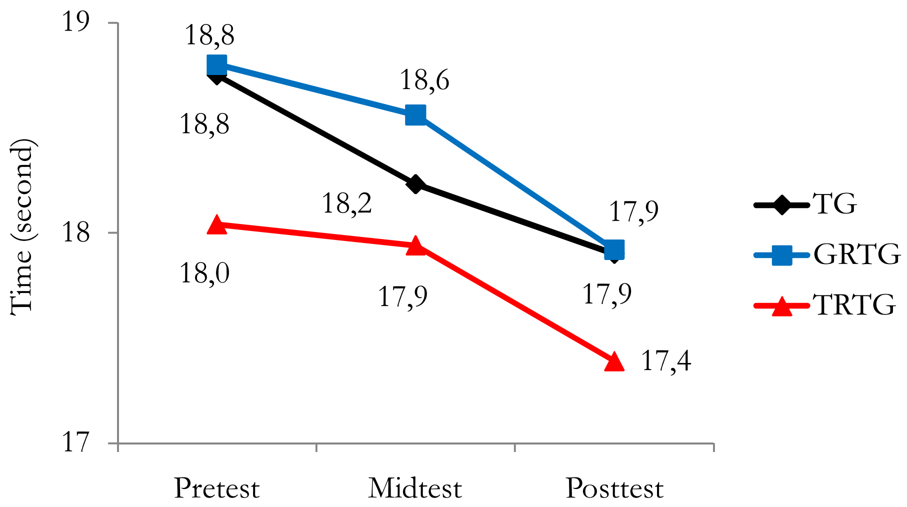


*Figure 13.* Pretest, Midtest, and Posttest Scores for AT

Table 11

Descriptive Statistics of Groups for Pretest, Midtest, and Posttest Scores for AT

| Group / | Pretest | | Midtest | | Posttest | |
|---|---|---|---|---|---|---|
| AT (sec) | *M* | SD | *M* | SD | *M* | SD |
| TG | 18.8 | 2.0 | 18.2 | 1.5 | 17.9 | 1.4 |
| GRTG | 18.8 | 2.2 | 18.6 | 1.8 | 17.9 | 1.4 |
| TRTG | 18.0 | 1.1 | 17.9 | 1.2 | 17.4 | 1.0 |

4.2. Initial Test Scores

Kruskal-Wallis Test was conducted to analyze the possible differences between initial test scores of groups. The test showed no significant differences for all pretest scores among groups. The Kruskal-Wallis Test results of groups for tennis training age (TTA) were presented in Table 12. Results showed that there were no significant differences among tennis training age scores of groups.

Table 12

Kruskal – Wallis Results of Groups for Tennis Training Age

| | *M* rank | $\chi 2$ | df | *P* |
|---|---|---|---|---|
| TG | 16,3 | ,57 | 2 | .751 |
| GRTG | 13,8 | | | |
| TRTG | 16,5 | | | |

The Kruskal-Wallis Test results of groups for International Tennis Number (ITN) were presented in Table 13. Results indicated that there were no significant differences among ITN scores of groups.

Table 13

Kruskal – Wallis Results of Groups for ITN

| | *M* rank | $\chi 2$ | df | *P* |
|---|---|---|---|---|
| TG | 13.3 | 1,44 | 2 | .487 |
| GRTG | 15.6 | | | |
| TRTG | 17.7 | | | |

Kruskal-Wallis Test results of groups for Untimed Consecutive Rally Test (UCRT) for 2m were presented in Table 14. Results demonstrated that there were no significant differences among UCRT (2m) scores of groups.

Table 14

Kruskal – Wallis Results of Groups for UCRT (2m)

| | *M* rank | $\chi 2$ | df | *P* |
|---|---|---|---|---|
| TG | 19,4 | 3,19 | 2 | .202 |
| GRTG | 14,7 | | | |
| TRTG | 12,5 | | | |

The Kruskal-Wallis Test results of groups for Untimed Consecutive Rally Test (UCRT) for 3m were presented in Table 15. Results showed that there were no significant differences among UCRT (3m) scores of groups.

Table 15

Kruskal – Wallis Results of Groups for UCRT (3m)

| | *M* rank | $\chi 2$ | df | *P* |
|---|---|---|---|---|
| TG | 18,7 | 2,24 | 2 | .326 |
| GRTG | 14,9 | | | |
| TRTG | 12,9 | | | |

Kruskal-Wallis Test results of groups for Rhythmic Competence Analysis Test (RCAT) for 50 bpm were presented in Table 16. Results indicated that there were no significant differences among RCAT (50 bpm) scores of groups.

Table 16

Kruskal – Wallis Results of Groups for RCAT (50 bpm)

| | *M* rank | χ2 | df | *P* |
|---|---|---|---|---|
| TG | 15,7 | ,91 | 2 | .633 |
| GRTG | 17,3 | | | |
| TRTG | 13,6 | | | |

Kruskal-Wallis Test results of groups for Rhythmic Competence Analysis Test (RCAT) for 100 bpm were presented in Table 17. Results demonstrated that there were no significant differences among RCAT (100 bpm) scores of groups.

Table 17

Kruskal – Wallis Results of Groups for RCAT (100 bpm)

| | *M* rank | χ2 | df | *P* |
|---|---|---|---|---|
| TG | 14,3 | ,32 | 2 | .851 |
| GRTG | 16,4 | | | |
| TRTG | 15,9 | | | |

Kruskal-Wallis Test results of groups for Agility Test (AT) were presented in Table 18. Results showed that there were no significant differences among AT scores of groups.

Table 18

Kruskal – Wallis Results of Groups for AT

| | *M* rank | χ2 | df | *P* |
|---|---|---|---|---|
| TG | 16,4 | ,90 | 2 | .637 |
| GRTG | 16,8 | | | |
| TRTG | 13,4 | | | |

4.3. Differences Between Initial, Mid, and Final Test Scores Within Each Group

Wilcoxon Test was conducted to examine the differences between pretest, midtest, and posttest within each group. As it is shown in Table 19, there was no significant difference between pre and midtest results of all groups when ITN scores were considered. Moreover, there was significant difference between pre and posttest results of all groups.

Table 19

Wilcoxon Test for ITN Scores of Groups' Pre-, Mid-, and Post-tests

| | TG | | GRTG | | TRTG | |
|---|---|---|---|---|---|---|
| | *M* rank | z | *M* rank | z | *M* rank | z |
| Pretest | 4.2 | 1.26 | 2.5 | 1.0 | 4.2 | 1.26 |
| Midtest | 3.5 | | 2.5 | | 3.5 | |
| Midtest | 3.7 | 1.73 | 4.5 | 2.58* | 4.5 | 2.58* |
| Posttest | 2.5 | | 0.0 | | 0.0 | |
| Pretest | 4.8 | 2.22* | 5.0 | 2.72** | 5.5 | 2.85** |
| Posttest | 2.5 | | 0.0 | | 0.0 | |

* $p<.05$, ** $p<.01$

As it is demonstrated in Table 20, there was no significant difference between pretest and midtest results of all groups when UCRT (2m) scores were considered. On the other hand, there was significant difference between pretest and posttest results of GRTG and TRTG.

Table 20

Wilcoxon Test for UCRT (2m) Scores of Groups' Pre-, Mid-, and Post-tests

| | TG | | GRTG | | TRTG | |
|---|---|---|---|---|---|---|
| | *M* rank | z | *M* rank | z | *M* rank | z |
| Pretest | 6.3 | 0.25 | 9.0 | 1.88 | 3.0 | 1.88 |
| Midtest | 5.0 | | 5.1 | | 6.6 | |
| Midtest | 3.3 | 1.78 | 5.5 | 1.68 | 5.0 | 2.29* |
| Posttest | 6.4 | | 5.5 | | 5.6 | |
| Pretest | 10.0 | 1.78 | 7.0 | 2.09* | 0.0 | 2.80** |
| Posttest | 5.0 | | 5.3 | | 5.5 | |

* $p$<.05, ** $p$<.01

As it is indicted in Table 21, there was significant difference between pretest and midtest results of TRTG when UCRT (3m) scores were considered. Additionally, there was significant difference between midtest and posttest and also between pretest and posttest results of GRTG and TRTG.

Table 21

Wilcoxon Test for UCRT (3m) Scores of Groups' Pre-, Mid-, and Post-tests

| | TG | | GRTG | | TRTG | |
|---|---|---|---|---|---|---|
| | *M* rank | z | *M* rank | z | *M* rank | Z |
| Pretest | 4.7 | 1.37 | 5.0 | 1.27 | 3.5 | 2.09* |
| Midtest | 5.9 | | 5.7 | | 6.0 | |
| Midtest | 6.7 | 0.76 | 8.0 | 1.98* | 1.0 | 2.70** |
| Posttest | 5.0 | | 5.2 | | 6.0 | |
| Pretest | 4.0 | 1.58 | 5.0 | 2.29* | 0.0 | 2.80** |
| Posttest | 6.1 | | 5.6 | | 5.5 | |

* $p$<.05, ** $p$<.01

As it is shown in Table 22, there was significant difference between pretest and midtest results of TRTG when RCAT (50 bpm) scores were considered. Besides, there was significant difference between midtest and posttest and also between pretest and posttest results of GRTG and TRTG.

Table 22

Wilcoxon Test for RCAT (50 bpm) Scores of Groups' Pre-, Mid-, and Post-tests

| | TG | | GRTG | | TRTG | |
|---|---|---|---|---|---|---|
| | *M* rank | z | *M* rank | z | *M* rank | z |
| Pretest | 6.8 | 0.05 | 6.0 | 0.53 | 2.7 | 1.98* |
| Midtest | 4.7 | | 4.5 | | 6.7 | |
| Midtest | 4.8 | 1.32 | 0.0 | 2.80** | 3.0 | 2.49* |
| Posttest | 5.8 | | 5.5 | | 5.8 | |
| Pretest | 3.5 | 1.37 | 1.5 | 2.49* | 0.0 | 2.80** |
| Posttest | 6.8 | | 6.5 | | 5.5 | |

* $p<.05$, ** $p<.01$

As it is demonstrated in Table 23, the Wilcoxon Test indicated significant difference between pretest and midtest results of GRTG and TRTG when RCAT (100 bpm) scores were considered. In addition, there was significant difference between pretest and posttest results of GRTG and TRTG.

Table 23

Wilcoxon Test for RCAT (100 bpm) Scores of Groups' Pre-, Mid-, and Post-tests

| | TG | | GRTG | | TRTG | |
|---|---|---|---|---|---|---|
| | *M* rank | z | *M* rank | z | *M* rank | z |
| Pretest | 4.8 | 1.32 | 2.0 | 2.60** | 0.0 | 2.80** |
| Midtest | 5.8 | | 5.9 | | 5.5 | |
| Midtest | 5.8 | 0.45 | 5.0 | 1.27 | 4.0 | 0.76 |
| Posttest | 5.3 | | 5.7 | | 7.0 | |
| Pretest | 3.7 | 1.68 | 0.0 | 2.80** | 5.0 | 2.29* |
| Posttest | 6.3 | | 5.5 | | 5.6 | |

* $p<.05$, ** $p<.01$

As it is shown in Table 24, there was no significant difference between pretest and midtest results of all groups when Agility Test scores were considered. Furthermore, there was significant difference between midtest and posttest and also between pretest and posttest results of all groups.

Table 24

Wilcoxon Test for AT Scores of Groups' Pre-, Mid-, and Post-tests

| | TG | | GRTG | | TRTG | |
|---|---|---|---|---|---|---|
| | *M* rank | z | *M* rank | z | *M* rank | z |
| Pretest | 6.8 | 1.37 | 6.2 | 0.35 | 5.0 | 0.25 |
| Midtest | 3.5 | | 4.8 | | 6.3 | |
| Midtest | 5.9 | 1.98* | 6.3 | 2.34* | 5.6 | 2.29* |
| Posttest | 4.0 | | 2.3 | | 5.0 | |
| Pretest | 6.0 | 2.09* | 5.5 | 2.80** | 6.5 | 2.49* |
| Posttest | 3.5 | | 0.0 | | 1.5 | |

* $p<.05$, ** $p<.01$

4.4. Improvement Scores of Groups

The Kruskal-Wallis Test was conducted to compare the improvement scores of groups. Kruskal – Wallis Test results of groups for improvement scores were presented in Table 25. Results showed that there were significant differences among UCRT (3m) and RCAT (50) scores of groups. Moreover, there were no significant differences for all other parameters among groups.

Table 25

Kruskal – Wallis Results of Groups for Improvement Scores

| Group/Tests | TG | | GRTG | | TRTG | | $\chi 2$ | *P* |
|---|---|---|---|---|---|---|---|---|
| | *M* | SD | *M* | SD | *M* | SD | | |
| ITN | -1.0 | 1.0 | -1.4 | 0.8 | -1.9 | 0.7 | 3.98 | 0.136 |
| UCRT 2m | 12.4 | 42.7 | 23.2 | 27.2 | 37.0 | 29.6 | 3.12 | 0.210 |
| UCRT 3m | 12.8 | 20.5 | 43.0 | 56.0 | 57.6 | 39.0 | 7.24 | 0.027* |
| RCAT 50 | 0.1 | 0.3 | 0.7 | 0.6 | 0.9 | 0.3 | 11.73 | 0.003** |
| RCAT 100 | 0.3 | 0.5 | 0.5 | 0.3 | 0.6 | 0.6 | 1.62 | 0.443 |
| AT | -0,8 | 1.1 | -0,9 | 1.0 | -0,6 | 0.4 | 0.05 | 0.975 |

* $p<.05$, ** $p<.01$

4.5. Pairwise Comparisons of Groups for Improvement Scores

Mann-Whitney U Test results of TG and GRTG were presented in Table 26. Results indicated that there was significant difference between RCAT for 50 bpm scores ($z=-2.15$, $p<.05$) of groups. Participants in the GRTG had higher improvement scores for the slow tempo rhythm test than the participants in the TG. There was no significant difference for all other parameters between groups.

Table 26.
Mann-Whitney U Test Results of TG and GRTG

| Group/Tests | TG<br>*M* rank | GRTG<br>*M* rank | *U* | *P* |
| --- | --- | --- | --- | --- |
| ITN | 11.4 | 9.7 | 41.50 | 0.496 |
| UCRT 2m | 9.2 | 11.8 | 37.00 | 0.326 |
| UCRT 3m | 8.9 | 12.1 | 34.00 | 0.226 |
| RCAT 50 | 7.7 | 13.4 | 21.50 | 0.031* |
| RCAT 100 | 8.9 | 12.1 | 34.00 | 0.226 |
| AT | 10.8 | 10.3 | 47.50 | 0.850 |

* $p<.05$

Mann-Whitney U Test results of TG and TRTG were presented in Table 27. Results demonstrated that there was significant difference between UCRT for 3m ($z=-2.79$, $p<.01$) and RCAT for 50 bpm ($z=-3.51$, $p<.01$) scores of groups. Participants in the TRTG had higher improvement scores for the forehand consistency test (3m) and the slow tempo rhythm test than the participants in the TG. There was no significant difference for all other parameters between groups.

Table 27.
Mann-Whitney U Test Results of TG and TRTG

| Group/Tests | TG<br>*M* rank | TRTG<br>*M* rank | *U* | *P* |
| --- | --- | --- | --- | --- |
| ITN | 12.9 | 8.2 | 26.50 | 0.059 |
| UCRT 2m | 8.1 | 12.9 | 26.00 | 0.070 |
| UCRT 3m | 6.8 | 14.2 | 13.00 | 0.005* |
| RCAT 50 | 5.9 | 15.2 | 3.50 | 0.000* |
| RCAT 100 | 9.2 | 11.8 | 37.00 | 0.326 |
| AT | 10.6 | 10.4 | 49.00 | 0.940 |

* $p<.01$

Mann-Whitney U Test results of GRTG and TRTG were presented in Table 28. Results showed that there was no significant difference for all parameters between groups.

Table 28.

Mann-Whitney U Test Results of GRTG and TRTG

| Group/Tests | GRTG<br>*M* rank | TRTG<br>*M* rank | *U* | *P* |
|---|---|---|---|---|
| ITN | 12.2 | 8.8 | 33.00 | 0.168 |
| UCRT 2m | 9.7 | 11.3 | 42.00 | 0.545 |
| UCRT 3m | 8.9 | 12.1 | 34.00 | 0.226 |
| RCAT 50 | 9.6 | 11.4 | 41.00 | 0.496 |
| RCAT 100 | 10.3 | 10.7 | 48.00 | 0.880 |
| AT | 10.9 | 10.1 | 46.00 | 0.762 |

4.6. Rhythmic Competence Scores of Participants for Different Tempos

Mann-Whitney U Test results of the pretest rhythmic competence scores of participants for the tempos 50 (bpm) and 100 (bpm) were presented in Table 29. Mann-Whitney U Test for the tempos was $z=-2.99$, $p<.01$, which was significant. Synchronization of participants' movements to the external stimulus was more precise at fast tempo than at slow tempo.

Table 29

Mann-Whitney U Test Results of the Pretest Rhythmic Competence Scores

| Tempo (bpm) | N | *M* | SD | *M* rank | *U* | *P* |
|---|---|---|---|---|---|---|
| 50 | 30 | 1.8 | 0.4 | 23.8 | 247.50 | 0.003* |
| 100 | 30 | 2.2 | 0.5 | 37,3 | | |

* $p<.01$

# CHAPTER V

# DISCUSSION

The aim of this study was to compare the effects of tennis specific and general rhythm training on the forehand consistency performance, rhythmic competence, tennis playing level and agility performance of tennis players. The study also attempted to examine the effects of different tempos on rhythmic competence of tennis players. It was hypothesized that participants in the rhythm training groups (GRTG and TRTG) were expected to exhibit higher improvement scores (pretest to posttest) than the participants in the Tennis Group. In addition, participants in the TRTG were expected to exhibit higher improvement scores than participants in the GRTG. Further, this study also aimed to investigate the effects of different tempos on rhythmic competence.

The Untimed Consecutive Rally Test (UCRT) was conducted to examine the forehand consistency performance of participants for two distances that were 2 and 3 meter from the tennis wall. Forehand consistency performance is adjusting the rhythm of body movement and the rhythm of forehand stroke performance in the trajectory and bouncing rhythm (Zachopoulou & Mantis, 2001). The UCRT was developed by Sherman (1972) in order to evaluate the accuracy and consistency with which a tennis player can hit consecutive rallies into the target. It was suggested that the UCRT corresponds to the game playing condition and is appropriate for both male and female tennis players having extensive range of tennis skill. 113 women undergraduate students, enrolled in six beginning tennis class in physical education department, participated to the Sherman's study. As a consequence, participants had a mean score of 20.50 (SD=16.62). The range was 3 to 118. This atypical distribution was explained by the fact that an individual's possible score was not limited. In other words, the score was based on the participants' ability to hit consecutive good rallies. It was reported that, since accuracy in time and space is needed for efficient forehand groundstroke in UCRT, it is necessary to adapt the rhythm of body movement and the rhythm of stroke performance in the trajectory and bouncing rhythm (Zachopoulou & Mantis, 2001).

Zachopoulou and Mantis (2001) applied UCRT by proposing a new version in order to analyze the effects of general rhythm training on rhythmic competence and forehand consistency of tennis players. The researchers conducted UCRT for two distances from the wall that were 2 and 3 meter. This version of UCRT was used for the present study to analyze the forehand consistency performance of the participants for each distance from the training wall.

The results of the current study revealed that the participants in rhythm training groups improved their UCRT (2m) performance significantly after the training protocol. No significant difference was found between pretest and posttest results of the participants in TG. Although no significant differences were found among groups, when pairwise comparisons applied for the UCRT (2m), the participants in TRTG improved their performance more than the participants in TG for a very close significance level ($p$=.07). The age of the participants might be a restrictive factor for the improvement. It is more difficult for adults when compared with children to adapt their movement to the rhythm. If the participants were exposed to rhythm trainings more than eight weeks, there may be significant difference between groups who had rhythm trainings and TG. According to Bourquin (2003), since the optimal time period to improve motor skills like rhythm is between the ages of 11 and 13, the training of young tennis players must focus on these skills during these ages.

Results also showed that the participants in rhythm training groups improved their UCRT (3m) performance significantly from pretest to posttest and also from midtest to posttest. There was no significant difference between pretest and posttest results of the participants in TG. Addditionally, the participants in TRTG improved their UCRT (3m) performance significantly more than the performance of the participants in TG. According to Thaut (2005), practicing rhythmic activities do not only regulate our movement but also provide opportunities to execute that movement more efficiently and precisely. Additionally, Zachopoulou et al. (2003) suggested that progression of the rhythmic ability causes to an improvement of the motor coordination. It was reported that rhythm training also regulates the timing of the sequence of muscle contractions that produce the movement (Thaut, 2005). Reid, Chow, and Crespo (2003) asserted that during stroke production, it is very important for a tennis player to control the movements of different body segments and coordinate the contractions of different muscles. There was no significant difference between TRTG and GRTG and between GRTG and TG when UCRT (3m) scores were considered. It appeared that tennis-specific rhythm training was a more effective method in order to enhance the forehand consistency performance than the general rhythm training. Throughout the training period, the participants in TRTG were trained in rhythmic movements that were tennis-specific. They performed nonlocomotor, locomotor and integrated rhythmic movements through using their rackets or balls, or both. On the other hand, the participants in GRTG practiced with only nonlocomotor and locomotor rhythmic movements.

Supportive findings were observed from the study of Zachopoulou and Mantis (2001). They reported that rhythm training has positive effects on forehand consistency and rhythmic ability. 8–10 years old fifty tennis players (23 girls and 27 boys) participated to their study. They distributed the participants into two sub-groups: experimental group and control group. The experimental group followed 10-week rhythm training, including locomotor skills that were performed in synchronization with external stimuli, at three different tempos 80, 100, 120. The rhythm training was conducted two times per week, for 16 minutes. The UCRT was used to test the forehand consistency performance for both 2 and 3 meter distances and a laboratory instrument was used to assess rhythmic ability for the tempos of 44 and 50 bpm before and after the training procedure. Results revealed that the participants in the experimental group significantly improved their forehand consistency performances for both distances and rhythmic ability for both tempos. No significant differences were found between pretest and posttest scores of participants in control group. Consequently, they concluded that the succession for the forehand groundstroke in tennis is highly related with players' rhythmic accuracy.

As a consequence, the two distances (2 and 3 meter) of the UCRT differentiated the success of the participants in the present study. It was suggested that the change of distance forces the players to adapt their movement to a change in the ball's trajectory and a change in its bouncing rhythm (Zachopoulou and Mantis, 2001). The participants in TRTG significantly improved their forehand consistency performance at the distance of 3 meter than the participants in TG. Although the participants in tennis-specific rhythm training group had better scores than the ones in general rhythm training group, no significant difference was found between rhythm groups for both distances. Furthermore, there was no significant difference between TRTG and TG when UCRT (2m) was considered. Results revealed that participants were better at distance of 3 meter than at distance of 2 meter. In other words, when the distance was longer the movement was executed with more accuracy. In that situation, the participants had more time to synchronize their movement to the coming ball. Supportively, Schmidt and Lee (2005) asserted that attempting to perform a task faster than its normal speed causes errors of movement control.

The High/Scope Rhythmic Competence Analysis Test (RCAT) was administered (Weikart, 1989) to assess the rhythmic competence of the participants for both slow (50 bpm) and fast tempos (100 bpm). The RCAT has been used by many researchers (David et al., 2007; Pollatou, Karadimou, & Gerodimos, 2005; Trump, 1987) interested in the field of motor behavior. Results indicated that the participants in rhythm training groups improved their RCAT (50 bpm) performance significantly from pretest to posttest and also from midtest to posttest. There was no significant difference between pretest and posttest results of the participants in TG. In addition, the participants in rhythm training groups improved their RCAT (50 bpm) performance significantly more than the performance of the participants in TG. In other words, participation to the general or sport-specific rhythmic activities caused to the development of rhythmic competence performance. Throughout experiment, participants in rhythm groups experienced rhythmic activities with different tempos. On the other hand, participants in tennis group were trained with only tennis sessions. Namely, participation to the sport-specific or general rhythm training facilitated progression in rhythmic competence performance. Although the participants in TRTG had better scores than the ones in GRTG, no significant difference was found between rhythm groups.

Contrasting results were found from the investigation of Groves (1969) which was focused on the effects of rhythmic training on motor-rhythmic ability. 131 children from first, second, and third grade participated in the study. After following 24-week rhythmic training, no significant differences were found between children who were trained and children had received no rhythmic training. It was concluded that age and maturation were more crucial than training when rhythmic synchronization ability was considered. On the other hand, results of the present study agree with the findings of Wight (1937), Trump (1987), Weikart (1989), Zachopoulou and Mantis (2001), and Zachopoulou et al. (2003). They pointed out that the development of rhythmic ability is considerably related with training. According to Gallahue (1982), practicing with locomotor and nonlocomotor activities to different tempos, intensities, and accents provide opportunity to enhance the fundamental elements of rhythm and skill in the movements as well. In addition, Trump (1987) asserted that the controlled and highly specific training strengthens the link between training and motor skill progression.

Results of the study also showed that the participants in rhythm training groups improved their RCAT (100 bpm) performance significantly after training period. There was no significant difference between pretest and posttest results of the participants in TG. Although the participants in rhythm training groups had better scores than the participants in TG, no significant difference was found between rhythm training groups and TG for the improvement scores. Namely, participation to the general or sport-specific rhythmic training was unable to provide improvement of rhythmic competence performance for the fast tempo. Additionally, there was no significant difference between TRTG and GRTG.

This finding might be explained with the similarity of time intervals between metronome beats for the fast tempo test (600 msec) and preferred tempo which was determined by previous investigations as approximately 600 msec (Fraisse, 1982; Kumai & Sugai, 1997; Baruch, Panissal-Vieu, & Drake, 2004). Baruch, Panissal-Vieu, and Drake (2004) investigated to determine a zone of preferred tempo in adults. 60 male and 60 female subjects with the mean age of 21 participated in the study. They concluded that the zone of preferred tempo for participants centered around 600 msec. In addition, Kumai (1999) found the same amount of time interval for the person with mental retardation. 64 mentally retarded subjects, ranging in mental age from 2 to 11 years, and in chronological age from 13 to 23 years were tested. Self-paced tempo was determined by asking subjects to tap a drum at a rate that felt easy and natural. As a result, the mean time interval was found approximately 600 msec for the self-paced tempo. According to Smith (1999), biological process like breathing, walking and heart beats are playing very important role on shaping the time duration for the preferred tempo. Since the participants of the current study responded to the fast tempo naturally, it was difficult to manipulate it through training. In contrast, at the slow tempo, they were asked to synchronize their movements to the exposed rhythm.

Supportive findings were also obtained from the studies of Kumai and Sugai (1997). They investigated the influence of the tempo on self-paced and rhythmic synchronization. 29 children, 3 to 6 years of age, were participated to the study. In order to analyze the self-paced rate-tapping, no stimulus was presented, and the participants were instructed to tap a drum at which rate they felt comfortable. The average interresponse intervals were found near 600 msec for the self-paced rate-tapping. On synchronized tapping task, participants were asked to tap in synchrony to the given tempos. The interstimulus interval was 600 msec, which was nearly the same as the self-paced one, for the fast tempo and the interval was 1200 msec for the slow tempo. Results showed no significant difference between self-paced and fast tempo scores of the participants. Eventually, it was reported that because the interstimulus interval of the fast tempo tapping task was similar to the self-paced one, it was not necessary to adjust the interresponse interval to obtain synchronization.

The ITN, used to assess tennis playing level of participants, was developed by International Tennis Federation in order to provide a standard method of classifying skill level of tennis players' globally (Crespo, Reid & Miley, 2003). Throughout the experimental procedure all groups participated in the regular tennis training that was twice a week and for one hour and fifteen minutes. Results showed that the mean ITN scores of each group increased significantly after training protocol. Although the participants in TRTG improved their performance more than the participants in TG for a very close significance level ($p$=.05), no significant differences were found among groups when ITN improvement scores were considered. It appeared that, regardless of the groups, participation to regular tennis training enhanced tennis playing level of all participants. Results also revealed that, participation to additional rhythm trainings was unable to differentiate tennis playing level of groups. Moreover, there was no significant difference between ITN scores of participants in rhythm groups.

The Spider Test, which takes part in ITN, was administered to evaluate the agility performance of participants. Crespo and Miley (1998) defined agility as an ability while moving to start and stop and to change direction quickly and effectively. Results indicated that the mean agility scores of each group progressed significantly from pretest to posttest. Nevertheless, no significant differences were found among improvement scores of groups. There was also no significant difference between participant in rhythm groups and TG, and between participants in sport-specific rhythm training group and in general rhythm training group. This finding might be explained with the nature of the game. According to Leone et al. (2006), tennis, an intermittent sport, can be characterized by repeated high-intensity short bursts of running and multiple explosive changes of directions. Namely, progression of agility performance was mostly related with participation to regular tennis training program. Verstegen and Marcello (2001) reported coordination and skill as critical elements in developing agility. They stated that the role of coordination is to execute the movements chosen in response to a stimulus and the role of skill is to orchestrate these coordinated abilities into an efficient and effective set of general, special, and sport-specific movements.

Results also revealed that synchronization of participants' movement to the external stimulus was more precise at fast tempo than at slow tempo. The mean pretest score for the slow tempo was 1.8 (SD=0.4) and for the fast tempo was 2.2 (SD=0.5). It seems that because the interval of preferred tempo was in correspondence with the interval of fast tempo test, participants performed better at fast tempo than at slow tempo.

This result is in accord with the findings of previous investigations (Ellis, 1992; Zachopoulou et al., 2000). For example, Mastrokalou and Hatziharitos (2007) studied the effects of tempo on rhythmic ability. 170 children between 6 to 9 years of age participated in the investigation. A lab-designed and constructed electronic instrument named the Analysis System of Rhythmic Ability was used to evaluate rhythmic ability of participants for slow (75 bpm) and fast (140 bpm) tempos. Results indicated that performance of the participants were better at fast tempo than at slow tempo.

# CHAPTER VI

# CONCLUSION

Although previous researches showed the existence and importance of rhythm and rhythm training in sport skills, there is no sufficient explanation or exercise prescription with regard to sport-specific rhythm training. This experimental study attempted to fill the lack of data in this field by testing the effects of rhythmic training particularly in tennis. The effects of regular tennis training, general rhythm training and tennis-specific rhythm training on forehand consistency, rhythmic competence, tennis playing level and agility performance were investigated.

Results of the study showed that participants in both rhythm training groups (GRTG and TRTG) improved their forehand consistency (for two distances) and rhythmic competence (for two tempos) performances significantly after experimental procedures. However, there was no significant difference between pretest and posttest results of TG. When forehand consistency improvement score was considered, there was no significant difference between GRTG and TG. Namely, general rhythm training failed to provide development in forehand consistency for both distances. On the other hand, with respect to UCRT (3m) improvement score, there was significant difference between TRTG and TG. Although there was no significant difference between TRTG and TG, the participants in TRTG improved their UCRT (2m) performance more than the participants in TG for a very close significance level ($p$=.07). It may be said that experiencing rhythmic activities through practicing with tennis-specific movements gave rise to progression in forehand consistency performance.

Furthermore, with regard to rhythmic competence, there was significant difference between slow tempo performance of the subjects in rhythm training groups and in TG. In other words, participation to the sport-specific or general rhythmic activities resulted in the development of rhythmic competence performance. However, no significant differences were found for the fast tempo improvement scores between groups. Namely, participation to sport-specific or general rhythm training failed to provide improvement of rhythmic competence performance for the fast tempo.

Participants in the rhythm training groups were also expected to have higher improvement scores on tennis playing level and agility performance in comparison to participants in the TG. The result of the study failed to support this hypothesis that there were no significant differences among groups when pairwise comparison conducted for the improvement score of ITN and AT. In other words, participation to additional rhythm trainings was unable to guarantee significant development. All groups significantly increased their tennis playing level and agility performance after experimental procedure. It appeared that, regardless of the groups, participation to regular tennis training caused progression on these parameters.

This experimental study also aimed to compare the effects of two different rhythm training methods which were sport-specific and general. Participants in TRTG were expected to exhibit higher improvement scores on all parameters than participants in GRTG. However, the results of the study failed to support this hypothesis. Although the participants in TRTG had better improvement scores on forehand consistency, rhythmic competence, and ITN than the ones in GRTG, no significant difference was found between rhythm training groups. In other words, participation to the tennis-specific or general rhythm training was unable to be a discriminative factor in forehand consistency, rhythmic competence, tennis playing level, and agility performance.

On the other hand, results of the study supported the third hypothesis that participants exhibited higher rhythmic competence scores on fast tempo in comparison to slow tempo. Indeed, since the time interval was similar to the preferred tempo, synchronization of participants' movement with the external stimulus was significantly more precise at fast tempo than at slow tempo.

Researchers who will replicate this study may consider altering some parts of the methodology. For example, this study might be reorganized with the larger sample size. In addition, since the adaptation of the children to the rhythmic movements is easier than adults, it would be preferable to study with children rather than adults. Furthermore, an electronic device could be used for the analysis of the rhythmic competence instead of the observers. Lastly, lengthening the duration and increasing the frequency of the rhythm trainings might be useful in order to obtain more powerful results.

Since the generalization of the results of this study was limited to tennis, it is strongly recommended for the future studies to explore new approaches to sport-specific rhythm trainings.

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# APPENDICES

## APPENDIX A

## KATILIMCI BİLGİLENDİRME FORMU

Değerli katılımcı “Ritim Antrenmanının Tenis Performansına Etkisi” adlı araştırmaya katılmanız için izninize başvurulmaktadır. Araştırmanın amaçları doğrultusunda Uluslararası Tenis Numaralandırma, çeviklik, ritim becerisi ve forehand istikrar performansı testleri uygulanacaktır. Araştırma süresi 10 haftadır. Ön-test ölçümlerinden sonra katılımcılar tesadüfî seçim yöntemi ile üç ayrı gruba (tenis grubu, genel ritim antrenmanı grubu, tenise özgü ritim antrenmanı grubu) dağıtılacaktır. Bütün gruplara 8 hafta boyunca haftada 2 kez, 1 saat 15 dakika süresince önceden belirlenen tenis antrenmanları uygulanacaktır. Genel ritim antrenmanı ve tenise özgü ritim antrenmanı gruplarına 8 hafta boyunca tenis antrenmanlarının öncesinde 15’er dakika farklı ritim çalışmaları uygulanacaktır. Araştırma süresince sizden beklenenler aşağıda sıralanmıştır:

1) Uygulanacak olan antrenman programlarına düzenli bir şekilde katılmak
2) Çalışma süresince ritim becerilerini içeren egzersiz programlarına katılmamak.
3) Araştırmacı tarafından uygulanacak olan tenis antrenmanları haricinde tenisle ilgili aktivitelere (duvar çalışması dahil) katılmamak.

Bu çalışmaya katıldığınız için şimdiden teşekkür ederiz. Çalışma hakkında daha fazla bilgi almak için Beden Eğitimi ve Spor Bölümü öğretim üyelerinden Yrd.Doç.Dr. Sadettin Kirazcı (Tel: 2104018; E-posta: skirazci@metu.edu.tr) ya da Beden Eğitimi ve Spor Bölümü doktora öğrencisi Mustafa Söğüt (Tel: 0506 5420646; E-posta: msogut@kku.edu.tr) ile iletişim kurabilirsiniz.

***Bu çalışmaya tamamen gönüllü olarak katılıyorum ve istediğim zaman yarıda kesip çıkabileceğimi biliyorum. Verdiğim bilgilerin bilimsel amaçlı yayımlarda kullanılmasını kabul ediyorum.***

| İsim Soyad | Tarih | İmza |
|---|---|---|
| | ____/____/_____ | |

APPENDIX B

SCORE SHEET FOR INTERNATIONAL TENNIS NUMBER TEST

Source: Crespo, M., Reid, M. & Miley, D. (2003). *Applied sport science for high performance tennis*. The International Tennis Federation, ITF Ltd.

## International Tennis Number – On Court Assessment

Name: Date of birth: Sex: M F
Assessor: Date: Venue:

| GS Dept | |
|---|---|
| FH 1 | |
| BH 2 | |
| FH 3 | |
| BH 4 | |
| FH 5 | |
| BH 6 | |
| FH 7 | |
| BH 8 | |
| FH 9 | |
| BH 10 | |
| Sub Total | |
| Consistency | |
| Total | |

| Volley Dept | |
|---|---|
| FH 1 | |
| BH 2 | |
| FH 3 | |
| BH 4 | |
| FH 5 | |
| BH 6 | |
| FH 7 | |
| BH 8 | |
| Sub Total | |
| Consistency | |
| Total | |

| GS Accucy | |
|---|---|
| FH DL 1 | |
| BH DL 2 | |
| FH DL 3 | |
| BH DL 4 | |
| FH DL 5 | |
| BH DL 6 | |
| FH CC 7 | |
| BH CC 8 | |
| FH CC 9 | |
| BH CC 10 | |
| FH CC 11 | |
| BH CC 12 | |
| Sub Total | |
| Consistency | |
| Total | |

| Serve | | |
|---|---|---|
| 1st Box Wide | 1 | |
| 1st Box Wide | 2 | |
| 1st Box Wide | 3 | |
| 1st Box Middle | 4 | |
| 1st Box Middle | 5 | |
| 1st Box Middle | 6 | |
| 2 st Box Wide | 7 | |
| 2 st Box Wide | 8 | |
| 2 st Box Wide | 9 | |
| 2st Box Middle | 10 | |
| 2st Box Middle | 11 | |
| 2st Box Middle | 12 | |
| Sub Total | | |
| Consistency | | |
| Serve Total | | |

This ITN Assessment was conducted in a accordance with the guidlines set forth in the Offical ITN Assessment Guide. I hereby agree to it's authenticicty

Signed by behalf of the player:

Signed by the assessor:

| Strokes Total | Agility Score | Totol Score |
|---|---|---|
| | | |

| Number of Assessment | New ITN Rating |
|---|---|
| | |

Table for Spider Test

| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 39 | 38 | 37 | 36 | 35 | 34 | 33 | 32 | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 12 | 14 | 15 | 16 | 18 | 19 | 21 | 26 | 32 | 39 | 45 | 52 | 61 | 76 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Score (F) | 57-79 | 80-108 | 109-140 | 141-171 | 172-205 | 206-230 | 231-258 | 259-303 | 304-344 | 345-430 |
| Score (M) | 75-104 | 105-139 | 140-175 | 176-209 | 210-244 | 245-268 | 269-293 | 294-337 | 338-362 | 363-430 |
| ITN | ITN 10 | ITN 9 | ITN 8 | ITN 7 | ITN 6 | ITN 5 | ITN 4 | ITN 3 | ITN 2 | ITN 1 |

APPENDIX C

SCORE SHEETS FOR RHYTHMIC COMPETENCY ANALYSIS TEST FOR TWO TEMPOS

| Name of Participant | 50 bpm | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | Mean |
| Patting the thighs with both hands | | | | | | | |
| Patting the thighs alternating the hands | | | | | | | |
| Walking the beat while still seated | | | | | | | |
| Walking the beat in one place | | | | | | | |
| Walking forward | | | | | | | |
| Walking backward | | | | | | | |
| Total Mean | | | | | | | |

| Name of Participant | 100 bpm | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | Mean |
| Patting the thighs with both hands | | | | | | | |
| Patting the thighs alternating the hands | | | | | | | |
| Walking the beat while still seated | | | | | | | |
| Walking the beat in one place | | | | | | | |
| Walking forward | | | | | | | |
| Walking backward | | | | | | | |
| Total Mean | | | | | | | |

APPENDIX D

GENERAL RHYTHM TRAINING

Slow Rhythmic Movements for General Rhythm Training

1) Side jump with both feet together. The landings of foot were synchronized with metronome beats.

2) Hand clapping in a synchronized manner with metronome beats.

3) Front and back jump with both feet together. The landings of foot were synchronized with metronome beats.

4) Walking in place. Landing of each step was synchronized with metronome beats.

Fast Rhythmic Movements for General Rhythm Training

1) Hand clapping in a synchronized manner with metronome beats.

2) Side walking. Landing of each step was synchronized with metronome beats.

3) Walking forward and backward. Landing of each step was synchronized with metronome beats.

APPENDIX E

TENNIS-SPECIFIC RHYTHM TRAINING

Slow Rhythmic Movements for Tennis-Specific Rhythm Training

1) Bouncing tennis balls with both hands at the same time. The landing of balls was synchronized with metronome beats.

2) Bouncing tennis balls with alternating hands. The landing of balls was synchronized with metronome beats.

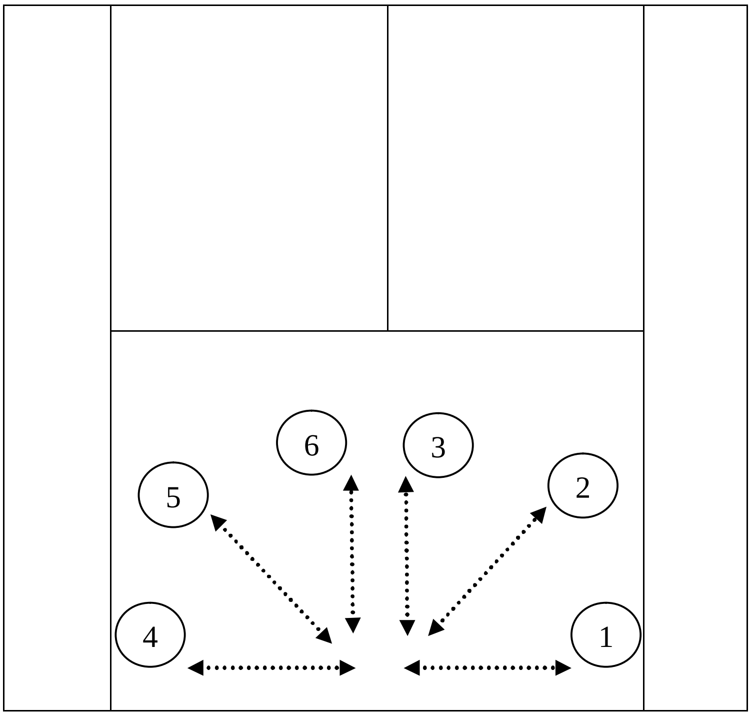
3) Bouncing tennis balls with both hands at the same time while walking. The landing of balls and steps were synchronized with metronome beats.

4) Bouncing tennis balls with alternating hands while walking. The landing of balls and steps were synchronized with metronome beats.

5) Bouncing tennis ball through forehand and backhand groundstroke with racket. The contact between racket and ball was synchronized with metronome beats.

1) Performing forehand and backhand strokes, without hitting ball in four phases which were started with split-step, and continued with backswing, contact and followthrough. Each phase was synchronized with metronome beats.

2) Bouncing tennis ball by forehand and backhand volley with racket. The contact between racket and ball was synchronized with metronome beats.




3) Performing ground strokes, without hitting the ball, in six phases by applying synchronized steps with metronome beats. The sequence in the exercise was; split-step, two steps towards the direction, forehand or backhand stroke and two back steps. Each of the phases was synchronized with metronome beats. Participants performed this drill for three directions (side, cross and front) for both forehand and backhand strokes.

APPENDIX F

HUMAN RESEARCH ETHIC FORM

1956

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25 Eylül 2008

Gönderilen: Prof. Dr. Feza Korkusuz
Beden Eğitimi ve Spor Bölümü
Başkanı

Gönderen : Prof. Dr. Canan Özgen
IAK Başkan Yardımcısı

İlgi : Etik Onayı

Beden Eğitimi ve Spor Bölümü Doktora öğrencisi olan Mustafa Söğüt'ün "Tenise Özgü Ritim Antremanlarının Tenis Oyuncularının Forehand İstikrar Performansı ve Ritim Becerisine Etkisinin İncelenmesi" başlığıyla yürüttüğü çalışması "İnsan Araştırmaları Etik Komitesi" tarafından uygun görülerek gerekli onay verilmiştir.
Bilgilerinize sunarım.

Saygılarımla

Etik Komite Onayı

Uygundur

25/09/2008

Prof. Dr. Canan ÖZGEN
Uygulamalı Etik Araştırma Merkezi
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APPENDIX G

TURKISH SUMMARY

RİTİM ANTRENMANININ TENİS PERFORMANSINA ETKİSİ

## 1. GİRİŞ

Ritim bir hareketi, belirli kalıplara uygun olarak, zamanında ve düzenli bir biçimde tekrar edebilme becerisidir (Kirchner and Fishburne, 1995). Yapılan çalışmalar (Borysiuk and Waskiewicz, 2008; Laurence, 2000; Pica, 1998; Shaffer, 1982; Weikart, 1989; Zachopoulou et al., 2000) ritmin farklı spor dallarındaki önemini ortaya koymuştur.

Ritim, oyunculara uyumlu hareket edebilme becerisi sağladığından tenis oyunu içinde oldukça önemlidir (Bourquin, 2003). Teniste iyi bir ritim; topla buluşma esnasında etkili bir kontrolü, topun başarılı bir şekilde gözlenmesini ve iyi bir zamanlamayı içermektedir (Segal, 2005). Tenisteki motor becerilerin yerine getirilmesi dışsal bir uyaran olan topun yörüngesi ile hareketler arasındaki senkronizasyonu gerektirmektedir (Zachopoulou et al., 2000).

Bu araştırmanın amacı; tenise özgü ve genel ritim antrenmanlarının forehand istikrar, ritim beceri, tenis oynama seviyesi ve çeviklik performansına etkilerinin karşılaştırılması ve farklı tempoların tenis oyuncularının ritim becerilerine etkilerinin incelenmesidir. Araştırma hipotezleri şu şekilde sıralanmıştır:

1. Ritim antrenmanı gruplarındaki (GRAG ve TRAG) katılımcıların, tenis grubundaki (TG) katılımcılara oranla forehand istikrar performansı, ritim becerisi, tenis oynama seviyesi ve çeviklik performansı parametrelerinde daha yüksek bir gelişim sağlayacakları beklenmektedir.
2. TRAG'da yer alan katılımcıların GRAG'da yer alan katılımcılara oranla forehand istikrar performansı, ritim becerisi, tenis oynama seviyesi ve çeviklik performansı parametrelerinde daha yüksek bir gelişim sağlayacakları

beklenmektedir.

3. Tempodaki uzun ve kısa zaman aralıklarının katılımcıların ritim becerilerinde farklılık meydana getireceği beklenmektedir.

## 2. YÖNTEM

Araştırma grubunu Uluslararası Tenis Numarası (ITN) ortalamaları 7,3 (SS=0,9) olan 30 üniversite öğrencisi oluşturmuştur. Katılımcılar tesadüfî seçim yöntemi ile üç ayrı gruba dağıtılmışlardır; tenis grubu (TG), genel ritim antrenmanı grubu (GRAG) ve tenise özgü ritim antrenmanı grubu (TRAG). Araştırmaya başlamadan önce bütün katılımcılara bilgilendirilmiş onam formu okutulmuş ve imzalatılmıştır.

Araştırma grubunun tenis oynama seviyelerinin belirlenmesinde Uluslararası Tenis Numarası Testi, çeviklik performanslarının değerlendirilmesinde ise ITN testinin içerisinde yer alan Örümcek Testi kullanılmıştır. Katılımcıların iki farklı tempodaki (50 ve 100) ritim becerilerinin ölçümünde bazı hareketler ile metronom vuruşları arasındaki senkronizasyonu değerlendirmek için tasarlanan High/Scope Rhythmic Competence Analysis Testi (RCAT) (Weikart, 1989) kullanılmıştır. Katılımcıların farklı iki mesafedeki (2 ve 3m) forehand istikrar performanslarının belirlenmesinde standart bir tenis duvarı ile ralli yapmayı içeren Untimed Consecutive Rally Testi (UCRT) (Sherman, 1972) kullanılmıştır.

Araştırma süresince bütün gruplar önceden belirlenmiş olan tenis antrenmanlarına katılmışlardır. TG sadece tenis antrenmanlarına, GRAG ek olarak genel ritim antrenmanlarına ve TRAG ek olarak tenise özgü ritim antrenmanlarına katılmıştır.

Grupların ön test değerleri arasındaki farkların ve gelişimlerinin analizinde Kruskal-Wallis testi, ön, ara ve son test değerleri farkları için ise Wilcoxon Testi kullanılmıştır. Grupların gelişim değerlerinin eşleştirilmeli karşılaştırılmasında ve farklı tempolardaki RCAT değerlerinin analizinde Mann-Whitney U testi kullanılmıştır.

## 3. BULGULAR

Araştırmadan elde edilen bulgular ritim antrenmanlarına katılan tenis oyuncularının forehand istikrar ve ritim beceri performanslarını anlamlı bir şekilde geliştirdiğini, tenis grubundaki katılımcıların değerlerinde ise bir fark olmadığını göstermiştir. Grupların gelişim değerleri incelendiğinde (Tablo 25), UCRT (3m) değerleri için TRAG ile TG arasında ve RCAT (50) değerleri için ritim antrenman grupları (GRAG ve TRAG) ile TG arasında anlamlı bir fark olduğu bulunmuştur. Ritim antrenmanlarına katılımın grupların tenis oynama seviyesi ve çeviklik performanslarına etkisinin olmadığı anlaşılmıştır. Ayrıca, farklı ritim antrenmanlarındaki tenis oyuncularının gelişim değerleri arasında anlamlı bir farklılık olmadığı bulunmuştur.

Tablo 25

Grupların Gelişim Değerleri İçin Kruskal – Wallis Sonuçları

| Group/Tests | TG | | GRTG | | TRTG | | χ2 | *P* |
|---|---|---|---|---|---|---|---|---|
| | Xort | SS | Xort | SS | Xort | SS | | |
| ITN | -1.0 | 1.0 | -1.4 | 0.8 | -1.9 | 0.7 | 3.98 | 0.136 |
| UCRT 2m | 12.4 | 42.7 | 23.2 | 27.2 | 37.0 | 29.6 | 3.12 | 0.210 |
| UCRT 3m | 12.8 | 20.5 | 43.0 | 56.0 | 57.6 | 39.0 | 7.24 | 0.027* |
| RCAT 50 | 0.1 | 0.3 | 0.7 | 0.6 | 0.9 | 0.3 | 11.73 | 0.003** |
| RCAT 100 | 0.3 | 0.5 | 0.5 | 0.3 | 0.6 | 0.6 | 1.62 | 0.443 |
| Çeviklik (sn) | -0,8 | 1.1 | -0,9 | 1.0 | -0,6 | 0.4 | 0.05 | 0.975 |

* $p<.05$, **$p<.01$

Katılımcıların farklı tempolardaki ön-test ritim beceri değerleri için Mann-Whitney U Test sonuçları Tablo 29'da verilmiştir. Mann-Whitney U Test sonuçları katılımcıların yavaş tempoya oranla hızlı tempodaki ritim becerilerinin daha yüksek değerde olduğunu göstermiştir.

Tablo 29

Ön-Test Ritim Beceri Değerleri İçin Mann-Whitney U Test Sonuçları

| Tempo | N | Xort | SS | *M* rank | *U* | *P* |
|---|---|---|---|---|---|---|
| 50 | 30 | 1.8 | 0.4 | 23.8 | 247.50 | 0.003* |
| 100 | 30 | 2.2 | 0.5 | 37,3 | | |

* $p$<.01

## 4. SONUÇ VE ÖNERİLER

Yapılan araştırmalar ritmin ve ritim antrenmanının önemini belirtmiş olmasına rağmen, spor dallarına özgü ritim antrenmanı konusunda yeterli bilgi bulunmamaktadır. Söz konusu alandaki eksikliği tenise özgü ritim antrenmanının etkilerini test ederek gidermeyi amaçlayan bu araştırmada, düzenli tenis antrenmanı, genel ritim antrenmanı ve tenise-özgü ritim antrenmanının forehand istikrar performansı, ritim becerisi, tenis oynama seviyesi ve çeviklik performansı üzerindeki etkileri araştırılmıştır.

Gruplara ait gelişim değerleri incelendiğinde TG ile GRAG arasında forehand istikrar performansı, hızlı tempo ritim testi, tenis oynama seviyesi ve çeviklik performansı bakımından anlamlı bir fark olmadığı, buna rağmen grupların yavaş tempodaki ritim beceri test değerleri arasında anlamlı bir fark olduğu anlaşılmıştır. Genel ritim antrenmanı grubunun yavaş tempodaki ritim becerilerindeki gelişimin, düzenli tenis antrenmanı grubununkine oranla daha fazla olduğu bulunmuştur.

TG ile TRTG arasında 2m'lik forehand istikrar performansı, hızlı tempo ritim testi, tenis oynama seviyesi ve çeviklik performansı bakımından anlamlı bir fark olmadığı, buna rağmen grupların 3m'lik forehand istikrar performansı ve yavaş tempodaki ritim beceri test değerleri arasında anlamlı bir fark olduğu anlaşılmıştır. Tenise-özgü ritim antrenmanı grubundaki gelişimin, düzenli tenis antrenmanı grubununkine oranla daha fazla olduğu saptanmıştır.

Tenise-özgü ritim antrenmanı grubunun forehand istikrar performansı, ritim becerisi ve tenis oynama seviyesindeki gelişim değerlerinin genel ritim antrenmanı grubuna oranla daha fazla olmasına rağmen farklı ritim antrenmanlarına katılımın test edilen parametreler üzerinde etkisi olmadığı anlaşılmıştır.

Temponun ritim becerisi üzerindeki etkileri incelendiğinde katılımcıların yavaş tempoya oranla hızlı tempodaki ritim becerilerinin daha yüksek olduğu belirlenmiştir.

Bu araştırma yöntem kısmında yapılacak olan bir takım değişiklikler ile tekrar edilebilir. Örneğin, daha büyük bir örneklem grubunun kullanılması ve ritim antrenmanlarının süresi ile sıklığında yapılabilecek bir artış daha güçlü veriler elde edilmesini sağlayabilir.

Bu araştırmadan elde edilen bulguların genellenebilirliği tenis oyunu ile sınırlı olduğundan, ileride bu konu üzerinde yapılacak çalışmalar için spor dallarına özgü ritim antrenmanlarına ilişkin yeni yaklaşımlar geliştirilmesi önerilmektedir.

APPENDIX H

# CURRICULUM VITAE

## PERSONAL INFORMATION


| | | |
|---|---|---|
| Surname, Name | : | Söğüt, Mustafa |
| Nationality | : | Turkish (TC) |
| Date and Place of Birth | : | 29.12.1978, Merzifon |
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## EDUCATION

| Degree | Institution | Year of Graduation |
|---|---|---|
| MS | Ankara University / PES | 2004 |
| BS | METU / PES | 2002 |

## WORK EXPERIENCE

| Year | Place | Enrollment |
|---|---|---|
| 2003-Present | Kırıkkale University | Instructor |
| 1999- | METU Tennis Club | Trainer |

**COURSES TAUGHT:** Coaching Tennis, Anthropometry, Physical Fitness

## FOREIGN LANGUAGE

English

**PUBLICATIONS / PRESENTATIONS**

Söğüt, M. & Kirazcı, S. Investigation of rhythmic abilities of junior competitive tennis players. *In proceedings of the 10th International Sport Sciences Congres. 23-25 October 2008. Bolu, Turkey.*

Söğüt, M. & Kirazcı, S. Investigation of coincidence timing accuracy and visual reaction time performance of athletes of different racket sports. *In proceedings of the 10th International Sport Sciences Congres. 23-25 October 2008. Bolu, Turkey.*

Söğüt, M., Koçak, S. & Ak, E. The effects of age and gender on coincidence timing accuracy of junior tennis players. *In proceedings of the 4th International Mediterranean Sports Science Congress, 9-11 November 2007. Antalya, Turkey.*

Ak, E., Söğüt, M., Uygur, M., Yıldırım, A., Cuğ, M., Korkusuz, F. & Özgider, C. The effects of 6-week callisthenic training on serve speed of 10–13 years old tennis players. *In proceedings of the 4th International Mediterranean Sports Science Congress, 9-11 November 2007. Antalya, Turkey.*

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Söğüt, M., Müniroğlu, S. & Deliceoğlu, G. (2004) Investigation of anthropometric and somatotype characteristics of junior male tennis players in different categories. *Spormetre – Ankara University Journal of Physical Education and Sport Sciences, II (4),* 155–162.

Deliceoğlu, G. & Söğüt, M. Investigation the interaction of the effects of physical skills, technical abilities and somatotype parameters of junior soccer team player. *In proceedings of the 8th International Sports Science Congress, 17-20 November 2004. Antalya, Turkey.*