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The Effect of 8-Week Apparatus Technique Training on Hand and Foot Simple, Selective and Discrimination Reactions of Female Athletes

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Abstract

Movement training is thought to be very important in terms of learning both basic motor skills and new techniques in sports branches. Rhythmic gymnastics apparatus technique applications, which is a widely used method in movement training; it aims to display predetermined choreography in harmony with various tools. In this context, the aim of this experimental study is to examine the effect of rhythmic gymnastics equipment technique, which is predicted to be a good tool to improve reaction performance for movement educators and athletes, on various hand and foot reaction parameters. A total of 42 female athletes, including 22 experimental group members who had not previously practiced rhythmic gymnastics and 20 control group members, were included in the study on voluntary basis. The reaction performances of the athletes were determined using the ÇAĞIN Hand and Foot Reaction Test. Data were analyzed using the SPSS 26.0 package program using Repeated Measures-ANOVA and descriptive statistics. In the pretest-posttest results of the reaction time of the individuals, it was determined that the hand simple and discriminative reaction time and foot discriminative reaction time of the experimental group decreased significantly ($p<0.05$). In the pretest-posttest results regarding the individuals' correct reaction rates, it was determined that only the foot selective reaction correct rate of the experimental group increased significantly ($p<0.05$). As a result of the study, it was observed that the application of the apparatus technique generally positively affected the athletes' hand and foot reaction times and the accuracy of the reactions.

Keywords: Training, rhythmic gymnastics, apparatus technique, reaction

Introduction

Movement development; it is expressed as the organism gaining mobility in direct proportion to the physical growth and development of the central nervous system. If movement development is not at the desired level, various disorders may occur in individuals. For this reason, movement training has a very important place in terms of acquiring and developing manipulative, locomotor and balance skills, especially in individuals in the developmental period (Gallahue et al., 2014). Physical education teachers have an important role in teaching skills determined through practices and methods appropriate to the child's developmental process. The physical education teacher must teach the child appropriate movements using certain steps and methods, depending on the purpose. Movement training is very important for coaches as well as physical education teachers. The coach needs to know how to teach a technique to an athlete who is new to the sport or how to ensure that a technique is perfect in a professional athlete. For this reason, it is very important for both physical education teachers and coaches to ensure diversity of methods and practices in movement training so that the development process can be carried out at the desired level. When the applications used for movement training are examined, it is observed that rhythmic gymnastics comes to the fore (Dobrijević et al., 2016; Skopal et al., 2020).

Rhythmic gymnastics, recognized as an Olympic sport, involves the presentation of technical movements within choreography characterized by beauty, grace, and aesthetic integrity, often combined with dance (Purenovic et al., 2016; Batista et al., 2018). Performances in rhythmic gymnastics feature a variety of apparatuses including rope, ball, hoop, clubs, and ribbon (Tsopani et al., 2012; Fédération International De Gymnastique, 2022). This discipline, aimed at seamlessly integrating body difficult and apparatus

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difficult, is renowned for its high technical complexity and rigorous physical demands (Batista et al., 2019; Debien et al., 2020). Mastery of an apparatus entails not only refining their use but also synchronizing their movements with those of the body. While studies on rhythmic gymnastics often emphasize flexibility (Moraru & Rusu, 2016) and coordination (Purenovic et al., 2016), it's worth noting that these skills are significantly bolstered by strength, speed, and endurance (Jastrjembskaia & Titov, 1999; Cabrejas et al., 2023; Ferreira Melo De Sá et al. 2023). Rhythmic gymnastics, with its fusion of apparatus difficult and body difficult accompanied by music, is distinguished by its visual and auditory appeal (Chiriac et al., 2020; Chiat et al., 2022; Çimen Polat et al., 2023; Yuzela et al., 2023). Moreover, adeptness in apparatus handling necessitates swift reaction times, crucial for executing techniques such as throwing and catching apparatuses (Poliszczuk et al., 2015). Gymnastics compared to other sports disciplines, it's worth noting that reaction performance holds particular prominence in gymnastics compared to other sports disciplines.

Reaction time serves as a vital metric, showcasing the swiftness and efficiency of decision-making across all sports (Sing & Sing, 2024). Magill categorizes reaction time into three distinct types: simple, selective and discrimination reaction times (Magill & Anderson, 2010). Simple reaction time involves responding to a single stimulus, while selective reaction time entails responding to multiple stimuli, each requiring a different response, and discrimination reaction time involves multiple stimuli with only one response (Çağın et al., 2024). In rhythmic gymnastics apparatus performance, all three reaction times hold significant importance. Athletes aspiring to excel in rhythmic gymnastics undergo rigorous training from a young age, aimed at developing motor skills, body techniques, and proficiency with apparatuses (Rudd et al., 2017). In contrast to the competitive field, in the humble training of rhythmic gymnastics for recreational purposes, it is noted that especially the training of instrumental technique positively affects active participation, enjoyment and motor skill development (Kezić et al., 2018). Consequently, the utilization of apparatuses in rhythmic gymnastics is believed to contribute significantly not only to elite athletes' performance but also to beginners in terms of various biomotor parameters.

Given this insight, it is believed that training in apparatus techniques could serve as a valuable resource for enhancing reaction performance across various sports disciplines, as well as in endeavors focused on refining object control. In this vein, the objective of this study is to investigate the impacts of 8 weeks of rhythmic gymnastics training on the simple, selective, and discrimination reaction performance of female athletes, specifically concerning hand and foot coordination.

Method

Research Design

The necessary permission and approval were obtained from the Ethics Commission of Gazi University (Code: 2023-196) and this experimental study was conducted in accordance with the Declaration of Helsinki. Participation in the study was voluntary. The participants were 42 volunteer female athletes who were randomly divided into two groups: experimental (N=22) and control groups (N=20). Both the experimental and control groups underwent measurements of simple, selective and discrimination reaction times at the beginning of the study. Subsequently, the experimental group engaged in an 8-week apparatus technique training program, comprising 60-minute sessions held three days a week (on Mondays, Wednesdays, and Fridays), in addition to their regular training sessions in their respective sports disciplines. Meanwhile, the control group continued with their usual training routines throughout the 8-week period. Following the completion of the 8-week intervention, reaction tests were administered once again to both groups (Figure 1).

Training Process

Throughout the 8-week exercise regimen, the experimental group participated in technical exercises utilizing a ball and ribbon. A routine warm-up consisting of 5 minutes of running followed by 15 minutes of general stretching was conducted, after which the main exercise session of 60 minutes commenced. The 30-minute segment of this session was dedicated to exercises with the ball, and the remaining 30 minutes were allocated to exercises with a ribbon. The exercises started at a beginner level for each apparatus, focusing on technical development and repetition-based

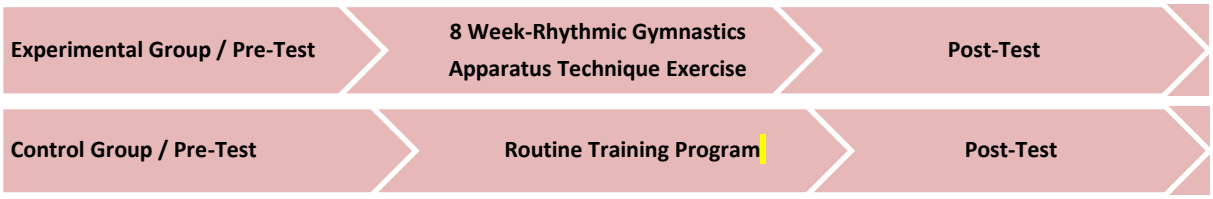

Fig. 1: Study Design

Table 1: Ball and ribbon apparatus technique exercises

	Experimental Group		*Control Group*
Apparatus	*Ball*	*Ribbon*	
Name of Technique	Large Roll of the Ball over minimum two large body segments	Spirals (min. 4-5 loops), tight and the same height in the air or on the floor	Routine Training
	Figures eight of the Ball with circle movement of the arm(s)	Swordsman" (min. 4-5 loops)	
	Catch of the Ball with one hand	Snakes (min. 4-5 waves), tight and the same height in the air or on the floor	
	Bounces: Series (min.3) of small bounces (below knee level) from the floor	"Boomerang": release, pull back of the stick by holding the end of the Ribbon, and catch of the stick	
	Bounces: One high bounce (knee level and higher) from the floor	"Echappé": rotation of the stick during its flight	
	Roll of the Ball on the floor	Rotational movement of the Ribbon stick around the hand	
	Roll of the body on the Ball on the floor	Wrapping (unwrapping)	
	Series of 3 rolls: a combination of small rolls	Movement of the Ribbon around a part of the body created when the stick is held by different parts of the body (hand, neck, knee, elbow) during body movements or Difficulties with rotation (not during "Slow Turn")	
	Series (min.3) of assisted small rolls on the floor or on the body	Medium circle of the Ribbon	
	"Flip-over" movement of the Ball	Spirals on the floor around the stick	
	Rotation(s) of the hand(s) around the ball	Roll of the Ribbon stick on a part of the body	
	Free rotation(s) of the Ball on a part of the body, including the free rotation of the ball on top of the finger	Large Roll of the stick over minimum two large body parts	
	Rebound on the floor after a high throw and direct retrieval using different parts of the body (not the hands)	Passing with the whole or part of the body through or over the pattern of the Ribbon	

training. As participants progressed, the complexity of the exercises increased, incorporating variations in position, direction, and difficulty level. Advanced techniques were gradually introduced, and connected technical exercises were incorporated to facilitate comprehensive skill development. All exercises adhered to the technical guidelines outlined in the Code of Points by the International Gymnastics Federation (FIG) and were conducted under the supervision of a senior coach (Table 1).

Study Group

A total of 42 female participants were recruited for the study, with 22 assigned to the experimental group and 20 to the control group. None of the participants had prior experience in rhythmic gymnastics. Table 2 presents detailed participant information. Inclusion criteria stipulated no acute illness, a minimum of 3 years of sports experience, no prior involvement in rhythmic gymnastics, and absence of color blindness (Table 2).

Data Collection Tools

Age, body weight and height information of the subjects were determined using a personal information form while reaction performances were determined using the ÇAĞIN Hand and Foot Reaction Test.

ÇAĞIN Hand and Foot Reaction Time Tests

The ÇAĞIN Hand and Foot Reaction Time Test battery utilizes FitLight Trainer or BlazePod devices to assess individuals' simple, selective and discrimination reaction performances. The ÇAĞIN Hand and Foot Reaction Time Tests are reaction test batteries with very high validity and reliability (Çağın et al., 2024). In this research, measurements were made with the FitLight Trainer device.

Table 2: Descriptive Statistics

Group	*Demographic Variables*	*Mean ± SD*
Experimental (n=22)	Height (cm)	1,68 ± 0,71
	Weight (kg)	59,41 ±11,67
	Age (years)	20,00 ± 0,92
	Sports Background (years)	9,27 ± 2,51
Control (n=20)	Height (cm)	1,64 ± 0,58
	Weight (kg)	59,75 ±7,52
	Age (years)	22,40 ± 6,12
	Sports Background (years)	4,60 ± 4,24

ÇAĞIN Color Blindness Test

Before administering the hand and foot reaction time tests, participants undergo the ÇAĞIN Color Blindness Test to determine their eligibility. During this test, participants are presented with random yellow, red, blue, and green colors and are asked to identify each color. Individuals who provide at least 2 correct answers for each color are deemed eligible for the test. Conversely, if a participant provides more than 1 incorrect answer, they are not included in the test.

ÇAĞIN Hand Simple Reaction Test

The test setup involves placing sensors and blue-colored cups on the table in accordance with protocol-specific guidelines. The participant is instructed to extinguish randomly illuminated blue lights within a 20-second timeframe. Following the extinguishing of each light, the participant must alternate hands and place the cup in the designated half area near them. Errors are recorded for instances where lights are extinguished without hand switching or cups are not placed in the specified area (1 point allocated for each error). Upon completion of the 20-second period, the participant's reaction time, the number of lights extinguished, and the total number of errors are documented for subsequent analysis. The test is administered twice, with the best performance from the two trials being considered for analysis.

ÇAĞIN Hand Selective Reaction Test

As per the protocol, sensors and cups of various colors (blue, red, yellow, and green) are arranged on the table according to specific guidelines. The participant is tasked with extinguishing randomly illuminated lights based on their corresponding colors by selecting the appropriate cup within a 20-second timeframe. Following the extinguishing of each light, the participant must alternate hands and place the cup in the designated half area near them. Errors are recorded for instances where the participant fails to switch hands, neglects to place the cup in the specified area, or extinguishes lights using the wrong-colored cup (1 point allotted for each error). Upon completion of the 20-second period, the participant's reaction time, the number of lights extinguished, and the total number of errors are documented for subsequent analysis. The test is administered twice, with the best performance from the two trials being considered for analysis.

ÇAĞIN Hand Discrimination Reaction Test

In adherence to protocol, sensors and a singular red-colored cup are meticulously arranged on the table. Participants are instructed to exclusively extinguish the red light amidst a simultaneous illumination of blue, red, green, and yellow lights within a 20-second timeframe. Following the extinguishing of each light, the participant must alternate hands and place the cup in the designated half area near them. Errors are tallied for instances where participants fail to switch hands, neglect to place the cup in the specified area, or extinguish the wrong light (1 point attributed for each error). Upon completion of the 20-second period, the participant's reaction time, the number of lights extinguished, and the total number of errors are documented for subsequent analysis. The test is administered twice, with the best performance from the two trials being considered for analysis.

ÇAĞIN Foot Simple Reaction Test

In accordance with the protocol, sensors and blue-colored rectangular papers are arranged on the floor according to specified measures. The participant is instructed to extinguish randomly illuminated blue lights within a 20-second timeframe. Following the extinguishing of each light, participants are required to switch feet, stepping onto a new blue paper, and change the paper itself. Errors are noted for instances where participants fail to alternate feet while

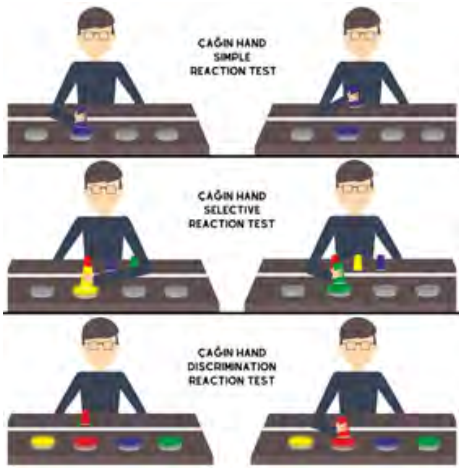

Fig. 2: ÇAĞIN Hand Simple, Selective and Discrimination Reaction Test

extinguishing lights (1 point allocated for each error). Upon completion of the 20-second period, the participant's reaction time, the number of lights extinguished, and the total number of errors are documented for subsequent analysis. The test is administered twice, with the best performance from the two trials being considered for analysis.

ÇAĞIN Foot Selective Reaction Test

Sensors and rectangular papers of various colors (blue, red, yellow, and green) are meticulously arranged on the floor according to protocol-specific guidelines. Participants are instructed to extinguish lights that will randomly illuminate based on their color by stepping on the corresponding paper for a duration of 20 seconds. Following the extinguishing of each light, participants are required to switch feet, stepping onto a new blue paper, and change the paper itself. Errors are tallied for instances where participants fail to alternate feet or extinguish lights by stepping on the paper of the wrong color (1 point assigned for each error). Upon completion of the 20-second period, the participant's reaction time, the number of lights extinguished, and the total number of errors are documented for subsequent analysis. The test is administered twice, with the best performance from the two trials being considered for analysis.

ÇAĞIN Foot Discrimination Reaction Test

Sensors and a single red-colored rectangular paper are meticulously positioned on the floor according to the designated protocol. Participants are instructed to exclusively extinguish the red light amidst a simultaneous illumination of blue, red, green, and yellow lights within a 20-second timeframe. Following the extinguishing of each light, participants are required to switch feet, stepping onto a new blue paper, and change the paper itself. Errors are documented for instances where participants fail to alternate feet or extinguish the wrong light (1 point attributed for each error). Upon completion of the 20-second period, the participant's reaction time, the number of lights extinguished, and the total number of errors are documented for subsequent analysis. The test is administered twice, with the best performance from the two trials being considered for analysis.

Statistical Analysis of ÇAĞIN Hand and Foot Reaction Time Tests

The ÇAĞIN Hand and Foot Reaction Time Tests yield data on subjects' mean reaction time, total touch count, and error count. Using these data, the subject's mean reaction time and the ratio of correct and incorrect reactions can be determined.

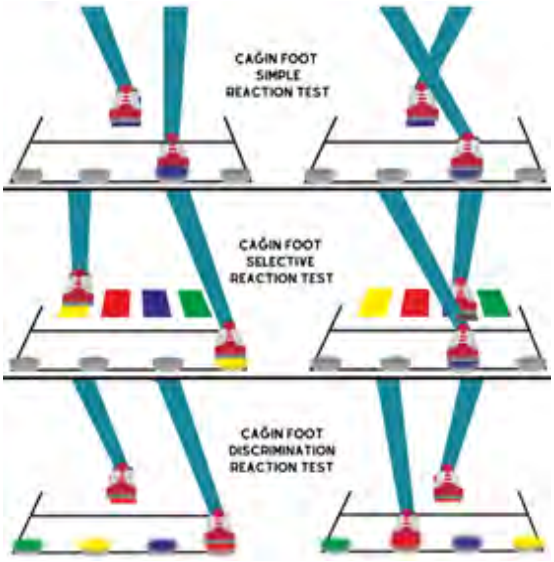

Fig. 3: ÇAĞIN Foot Simple, Selective and Discrimination Reaction Test

Mean Reaction Time: This parameter is automatically computed by the FitLight Trainer or BlazePod device following the 20-second test (e.g., 0.666 milliseconds).

Ratio of Correct and Incorrect Reactions: The ratio is calculated as the subject's total touch count divided by the error count. For instance, if a subject touches the sensors 10 times and makes 2 errors, their correct reaction rate is 80%, and their incorrect reaction rate is 20%.

Data Analysis

Analysis of the data obtained from the study was performed with the SPSS program (version 26.0; IBM Corp., Armonk, NY). In the study, mean and standard deviation values were taken as descriptive statistics. Repeated Measures-ANOVA analysis was used to analyze the data in general. The confidence interval was chosen as 95% and values below $p<0.05$ were considered statistically significant.

Findings

Findings of the study are presented using tables and figures as follows in Table 3.

a. It is seen that the average hand simple reaction time of the participants did not differ between the experimental and control groups (F=,088; p=,768). In addition, it was determined that the participants' pre-measurement and post-measurement averages differed over time (F=5,355; p=,026). Accordingly, it is understood that there is a decrease in the values of both the experimental and control groups. Finally, no significant difference was found in the group-time interaction (F=,430; p=,516).

b. the average hand-selected reaction time of the participants did not differ between the experimental and control groups (F=,831; p=,367). It was determined that the participants' pre-measurement and post-measurement averages did not differ according to time (F=3,827; p=,057). Finally, no significant difference was found in the group-time interaction (F=3,560; p=,066).
c. the average hand-separated reaction time of the participants did not differ between the experimental and control groups (F=,021; p=,884). It was determined that the participants' pre-measurement and post-measurement averages differed over time (F=15,730; p=,000). Accordingly, it is seen that there is a decrease in the values of both the experimental and control groups. Finally, a significant difference was obtained in the group-time interaction (F=8,317; p=,006).
d. the average foot simple reaction time of the participants differed between the experimental and control groups (F=5,399; p= ,025). It was determined that the participants' pre-measurement and post-measurement averages did not differ according to time (F=3,980; p =,053). Finally, no significant difference was found in the group-time interaction (F=1,127; p =,295).
e. the average foot selective reaction time of the participants did not differ between the experimental and control groups (F=7,544; p =,009). It was determined that the

Table 3: According to the participants' groups and measurement times; comparison of hand and foot simple, selective and discriminative reaction time averages

			Pre Test	*Post Test*	*Total*			
	Variables	*n*	$\overline{X}$ ± *SS*	$\overline{X}$ ± *SS*	$\overline{X}$ ± *SS*	*%Δ*	*F*	*p*
Hand Simple R.T. (ms)	Experiment	22	,75±,10	,72±,11	,73±,02	%-4	,088	,768
	Control	20	,76±,15	,74±,17	,75±,03	%-2,6		
	Total	42	,75±,13	,73±,14				
	F=5,355; p=,026					Group X Time Interaction F=,430; p=,516		
Hand Selective R.T. (ms)	Experiment	22	1,15±,14	1,08±,14	1,15±,02	%-6,08		
	Control	20	1,15±,15	1,14±,14	1,11±,02	%-0,86	,831	,367
	Total	42	1,15±,14	1,11±,15				
	F=3,827; p=,057					Group X Time Interaction F=3,560; p=,066		
Hand Discrimination R.T. (ms)	Experiment	22	,77±,10	,67±,09	,72±,02	%-12,98		
	Control	20	,72±,08	,71±,11	,71±,02	%-1,38	,021	,884
	Total	42	,74±,09	,69±,10				
	F=15,730; p=,000					Group X Time Interaction F=8,317; p=,006		
Foot Simple R.T. (ms)	Experiment	22	,65±,15	,59±,09	,62±,05	%-9,23		
	Control	20	,81±,33	,79±,35	,80±,05	%-2,46	5,399	,025
	Total	42	,72±,26	,69±,26				
	F=4,083; p=,050					Group X Time Interaction F=1,127; p=,295		
Foot Selective R.T. (ms)	Experiment	22	1,03±,21	,96±,29	1,00±,05	%-6,79		
	Control	20	1,22±,26	1,19±,25	1,21±,05	%-2,45	7,544	,009
	Total	42	1,12±,25	1,07±,29				
	F=3,980; p=,053					Group X Time Interaction F=,236; p=,630		
Foot Discrimination R.T. (ms)	Experiment	22	,63±,10	,57±,08	,60±,01	%-9,52		
	Control	20	,66±,09	,64±,10	,65±,02	%-3,03	2,840	,100
	Total	42	,64±,09	,61±,10				
	F=9,383; p=,004					Group X Time Interaction F=2,941; p=,094		

R.T.:Reaction Time

participants' pre-measurement and post-measurement averages did not differ according to time (F=3,980; p =,053). Finally, no significant difference was found in the group-time interaction (F=,236; p=,630).

f. the average foot separation reaction time of the participants did not differ between the experimental and control groups (F=2,840; p=,100). It was determined that the participants' pre-measurement and post-measurement averages differed over time (F=9,383; p =,004). Accordingly, it is seen that there is a decrease in the values of both the experimental and control groups. Finally, no significant difference was found in the group-time interaction (F=2,941; p=,094) (Table 4).

As can be seen in the table, in the study, it was determined that;

a. the average hand simple correct reaction rate of the participants did not differ between the experimental and control groups (F=,122; p=,729). It was determined that the participants' pre-measurement and post-measurement averages did not differ according to time (F=,779; p=,383). Finally, no significant difference was found in the group-time interaction (F=,191; p=,664).

b. the average hand-selected correct reaction rate of the

Table 4: According to the participants' groups and measurement times; comparison of hand and foot simple, selective and discriminative correct reaction averages

			Pre Test	*Post Test*	*Total*			
	Variables	*n*	$\overline{X}$ ± *SS*	$\overline{X}$ ± *SS*	$\overline{X}$ ± *SS*	*%Δ*	*F*	*p*
Hand Simple R.C.R. (%)	Experiment	22	92,68±20,99	96,09±4,35	94,38±1,65	%3,67	,122	,729
	Control	20	94,65±4,47	95,80±4,58	95,22±1,73	%1,21		
	Total	42	93,62±15,3	95,95±4,41				
	F=,779; p=,383					Group X Time Interaction F=,191; p=,664		
Hand Selective R.C.R. (%)	Experiment	22	88,73±7,31	92,32±9,09	90,52±1,27	%4,04	,389	,536
	Control	20	91,05±5,53	92,30±5,93	91,67±1,33	%1,37		
	Total	42	89,83±6,55	92,31±7,66				
	F=3,926; p=,054					Group X Time Interaction F=,918; p=,344		
Hand Discrimination R.C.R. (%)	Experiment	22	95,05±3,42	95,55±4,07	95,29±,61	%0,52	6,681	,014
	Control	20	98,10±2,42	97,10±4,27	97,60±,64	%-1,01		
	Total	42	96,50±3,33	96,29±4,19				
	F=,134; p=,716					Group X Time Interaction F=1,210; p=,278		
Foot Simple R.C.R. (%)	Experiment	22	95,64±4,64	96,09±4,35	95,864±,90	%0,47	,001	,978
	Control	20	96,00±4,40	95,80±4,58	95,90±,94	%-0,20		
	Total	42	95,81±4,47	95,95±4,41				
	F=,072; p=,790					Group X Time Interaction F=,477; p=,494		
Foot Selective R.C.R. (%)	Experiment	22	88,41±7,18	92,14±6,43	90,27±1,98	%4,21	,040	,842
	Control	20	90,85±12,02	90,84±12,2	90,85±2,08	%-0,01		
	Total	42	89,57±9,74	91,52±9,54				
	F=4,858; p=,033					Group X Time Interaction F=4,868; p=,031		
Foot Discrimination R.C.R. (%)	Experiment	22	95,45±2,98	97,45±3,54	95,27±,69	%2,09	7,457	,009
	Control	20	95,10±5,67	93,00±4,97	95,22±,66	%-2,20		
	Total	42	95,29±4,41	95,33±4,79				
	F=,002; p=,961					Group X Time Interaction F=3,989; p=,053		

R.C.R.:Reaction Correct Rate

participants did not differ between the experimental and control groups (F=,389; p=,536). It was determined that the participants' pre-measurement and post-measurement averages did not differ according to time (F=3,926; p=,054). Finally, no significant difference was found in the group-time interaction (F=,918; p=,344).

c. the average hand-separated correct reaction rate of the participants differed between the experimental and control groups (F=6,681; p=,014). It was determined that the participants' pre-measurement and post-measurement averages did not differ according to time (F=,134; p=,716). Finally, no significant difference was found in the group-time interaction (F=1,210; p=,278).

d. the average foot simple correct reaction rate of the participants did not differ between the experimental and control groups (F=,001; p=,978). It was determined that the pre-measurement and post-measurement averages of the participants did not differ according to time (F=,072; p=,790). Finally, no significant difference was found in the group-time interaction (F=,477; p=,494).

e. the average foot choice correct reaction rate of the participants did not differ between the experimental and control groups (F=,040; p=,842). It was determined that the participants' pre-measurement and post-measurement averages differed over time (F=4,858; p=,033). Accordingly, it can be seen that while the values of the experimental group increased, the values of the control group decreased. Finally, a significant difference was found in the group-time interaction (F=4,868; p=,031).

f. the average foot discrimination correct reaction rate of the participants differed between the experimental and control groups (F=7,457; p=,009). It was determined that the participants' pre-measurement and post-measurement averages did not differ according to time (F=,002; p=,961). Finally, no significant difference was found in the group-time interaction (F=3,989; p=,053).

Discussion and Conclusions

In the study it has been aimed to examine the effects of hand and foot on simple selective and discriminative reaction performance after an 8-week rhythmic gymnastics training for female athletes. When the individuals' reaction time pretest-posttest results are examined; it was determined that the hand simple and discriminative reaction time and foot discriminative reaction time of the experimental group decreased significantly (p<0,05). In the pretest-posttest results regarding the individuals' correct reaction rates, it was determined that only the foot selective reaction correct rate of the experimental group increased significantly (p<0,05). Reviewing the literature, a pertinent study highlighted that after an 8-week training period involving rope, ball, and hoop, apparatus technique significantly enhanced various aspects of the educational process. These enhancements included improvements in body skills, balance, eye-hand coordination, laterality, spatial orientation, rhythmic perception, body expression, and sensorimotor abilities. Furthermore, the cognitive demands associated with rhythmic gymnastics and the utilization of high-intensity anaerobic metabolism suggest potential improvements in executive functions. This study contributes significantly to the existing literature by proposing that rhythmic gymnastics not only enhances selective attention and working memory but also enriches overall quality of life (Carvalho et al., 2023). The findings of our study align with these literature findings, suggesting that apparatus exercises generally enhance reaction parameters. Considering that reaction parameter is a critical performance metric reflecting decision-making speed and efficiency, it can be posited that the utilization of apparatus in rhythmic gymnastics may provide supportive benefits not only for gymnasts but also for sedentary individuals. In the context of rhythmic gymnastics, this role can be elucidated as follows: each apparatus, such as ball and ribbon, imposes its unique set of rules, and executing each element within these rules demands meticulous practice and adherence to technique. For instance, when aiming to execute a 'one-handed catch' with a ball, the correct technique involves making initial contact with the fingertips as the ball meets the hand, followed by securely catching the ball with the palm of the hand. Hence, depending on the angle of incidence of the ball, adjustments to the body, arm, and hand positioning, as well as decision-making regarding how to react to the specific situation, will vary accordingly. Alternatively, when executing the 'echappe' technique with a ribbon, the proper method involves intercepting the end of the stick with the hand while the stick and the fabric piece of the ribbon are in mid-air. Once more, reaction parameters emerges as a crucial factor in this context. Since rhythmic gymnastics involves the manipulation of apparatus not only with the hands but also with other body parts, reaction is deemed crucial not only for the hands but also for the feet and other involved body parts.

Looking at it from another angle, the mastery of apparatus control and the pursuit of executing correct techniques can also contribute to the development of object control skills, which are considered fundamental movement skills. Rudd et al. (2017) observed that children who participated in 16 weeks of gymnastics training demonstrated significant enhancements in balance and object control skills compared to those engaged in standard physical education. This study suggested that incorporating gymnastics-based physical

education curriculum led to an expedited improvement in movement proficiency compared to traditional physical education approaches, resulting in greater advancements in stability skills and object control abilities. Several studies in the literature have extensively explored the potential advantages of integrating rhythmic gymnastics into school physical education curricula (Bahodirovna & Ilxomjonovich, 2022; Xaitbayeva, 2024). These studies highlight numerous areas of potential benefit, including enhancements in flexibility, strength, endurance, coordination, reaction time, posture correction, grace training, creative thinking, emotional well-being, and social interaction (Xaitbayeva, 2024). In this context, Abdullayev (2024) underscored that gymnastics stands as one of the most significant tools for enhancing physical education in schools and can serve as a potent vehicle for fostering physical development among schoolchildren. Gymnastics plays a pivotal role in shaping and refining students' motor functions. Therefore, rhythmic gymnastics can serve as a valuable tool for children's development during the fundamental movement education period. Rhythmic gymnastics stands out as a distinctive sport that entails rigorous training, yet it can also be enjoyed recreationally, even by individuals who are not gymnasts. Engaging in recreational rhythmic gymnastics activities can offer a fresh perspective on exercises, thanks to their enjoyable and distinctive nature. Moreover, they can foster innovation, particularly in enhancing reaction parameters.

In conclusion, the apparatus technique emerges as a valuable tool, particularly in sports disciplines where reaction holds significance. Moreover, it is perceived as a crucial practice for athletes to swiftly and precisely respond to stimuli during competitive events. Additionally, owing to its favorable impact on individuals' rapid and accurate reaction performances, the apparatus technique is deemed effective for enhancing both cognitive and biomotor skills. Furthermore, its enjoyable nature serves as a motivating factor for individuals, enhancing its practicality and applicability. Therefore, the apparatus technique stands as a pivotal option in exercise practices aimed at cultivating object control skills. As a result, it can be assumed that rhythmic gymnastics equipment technique can be an effective tool for both physical education teachers and coaches in teaching movement and sports branches where reaction skills are at the forefront.

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