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RESEARCH ARTICLE

COMPARING ATHLETES' AUDIO-VISUAL REACTION PERCEPTION AND RHYTHMIC PERCEPTION

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Abstract

This study was performed in the silent environment and the aim was analyzing athletes' right-left hand audio and visual reaction scores/responses and understanding the relationship between audio and visual perception and rhythmic perception which was tested with a specific rhythm pattern. Totally, 24 students who were in Gazi University Physical Education and Sports School joined to this study.

Test subjects' audio and visual reaction time measurements were obtained with NEWTEST 1000 in the silent environment. Data obtained from the study were analyzed with SPSS 25.0 (Statistical Package for Social Sciences).

To examine the rhythmic perception of subjects, a special rhythm pattern was used. In the analysis phase, sound recordings (in .wav format) were processed with using MATLAB and resulting signals were compared in the power spectrum area. In the interpretation phase, the similarity rates between test subjects' rhythms and the original test rhythm were calculated by MSE (Mean Squared Error) statistical function.

At the end of the analysis, average visual reaction times for left hand and for right hand and average audio reaction times for left hand and for right hand in the silent atmosphere were calculated as 203,375 ms; 199,541 ms, 190,625 ms; 180,833 ms, respectively.

According to the statistical analysis of audio and visual reaction data, athletes' audio reaction perception was better than visual reaction perception. Also, for analyzing the dominance of right-left hand, generally, it was observed that right hand was more dominant in the audio reaction measurements.

According to the obtained data, in the rhythm perception phase, results which were closer to the original rhythm pattern were evaluated from the participants whose audio reaction times were shorter than visual reaction times. Indeed, the success rate in rhythm perception was calculated as 89%. Indeed, a significant correlation was found between audio reaction times and rhythm perception.

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INTRODUCTION

Music is a subset of sounds which are reproduced with a specific purpose by using feelings and impressions[1]. Generally, musical memory of the brain is consisted from audio, visual, tactile or muscular for the special parameters of the perceived sensations[2].

A unique thought for athletes is using musical memory to improve the performance parameter[3]. Present researches show that music has a lot of advantages for exercise and relaxation[4]. According to the studies, exercise with music has different effects on the whole system of human body[5]. Also, it is a factor that music is used to improve the skills of visualization in sport[6].

As a result of the similarity between music rhythm and human movement, a harmony is found between music and exercise[7]. Researches show that, the relationship between music and exercise can be used to understand the environment and improving motor skills[8]. Also, it is found that, paced music can affect the hearth rhythm[9].

Melodic and harmonic musical harmony is determined to ensure the athletes' energy. Music which is combined from athletes' cultural accumulation, can affect the mood positively[10]. According to this thought, music can affect the physical activity with athletic work.

For determining ability of athletes, recent studies show that, this is a combined mix of the human body and sports[11]. Reaction time and dominant hand using are sub-components of this system[12]. Reaction time is an inherited property which is generally given against external alerts[13].

Despite there are some factors to affect the reaction time response, a few studies were done for calculating the reaction times in silent environment[14]. Factors to affect reaction times positively are attention, motivation, speed training, warming, education level and mental habits, negative factors are alcohol, insufficient exercise, fatigue, age, gender, type of stimulus and psycho-physiological factors. Indeed, despite a lot of factors which affect the reaction times are mentioned in the literature, the relationship between audio and visual reaction times and rhythm perception is not mentioned properly.

The aim of this study is to investigate audio and visual reaction times in the silent environment and determine the relationship between audio and visual reaction times and rhythm perception.

MATERIALS AND METHODS

This research was performed with the participation of 24 students (12 women, 12 men) who were studying in Gazi University Physical Education and Sports School. No-smoking and dealing with a branch of sports were important criteria for choosing these student. Test subjects' age, body weight and training age values were 21.048 ± 1.50 year 188,55 ± 6,42 centimeter, 77,28 ± 6,21 kilogram and 6,80 ± 6,0 year, respectively. Measurements were taken in Gazi University Physical Education and Sports School Performance Laboratory.

Data Collection

Height parameters of the subjects' were measured with a metal meter whose sensitivity was 0.1 cm and body weights were taken with bare feet and light clothing and measurements were done with a weighbridge whose sensitivity was 0.1 kg.

Players' audio and visual reaction time measurements were evaluated with NEWTEST 1000 tool. Audio and visual reaction time scores were evaluated for both hands with using the electronic reaction time measurement tool. Generally, this tool gives 3 stimuli to the user. Stimuli of 1 and 3 give visual (light), stimuli of 2 gives audio (sound) stimulant. Measurements have taken for 1,5 months, especially for every Monday, between 13:00-16:00 pm. For recording measurement results, an information form was prepared for all athletes. During the measurement part, NEWTEST 1000 tool was placed 10 cm away from the test subjects. With "Ready" command, when the sound or light stimulant was given, pressing the tool's button immediately was requested. Totally, 3 trial chances were given to each of the participants, the best result was recorded in milliseconds as the reaction response.

To analyze the rhythmic perception of test subjects', a unique original rhythm pattern was used. Note sequence of the rhythm pattern was shown in Figure-1.

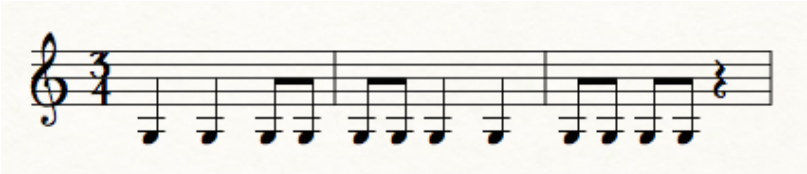


Figure-1: Note sequence of the original rhythm pattern

During data collection, before recording, original rhythm pattern was listened only once to every participant. Also, three chances were given to every subject to establish an adaptation in their memory. Then, repeating the rhythm was expected from the participants. Rhythm repetition stage was performed with a special pencil and a wooden table and the rule of this process was generally "hitting the table with the pencil with light pulses". In addition, athletes' rhythm repetition records were taken with Logic Pro X sound recording program in the silent environment and recorded sounds which were in wav. format were stored in the computer.

Data Analysis

In the data solution and interpretation stage; Descriptives, Variance Analysis and Significant Test were used as the optimal analyzing methods and $p<0.05$ significance level was achieved. To evaluate the data and to find the calculated value, SPSS 25.0 (Statistical package for social sciences) was used in detail.

In the analysis stage of the rhythmic perception, to process sound files, Signal Processing Toolbox was used in MATLAB. Firstly, for inspection, sound signals which belonged to the original rhythm and 24 participants were transformed to the power spectrum (PSD) area at the 95% confidence level. Then, each of the athletes' PSD curves was compared to the original rhythm's PSD curve with using multiple imaging and top fitting methods. For these methods, optimal fitting was performed in the ±1.50 dB boundary condition. After fitting, maximum amplitude value between the original signal and each of the participants' power spectrum signals. If the difference value was 0, it was accepted that maximum matching was obtained.

In the interpretation stage, these difference values were calculated as error rates by MSE (Mean Squared Error) function and similarity rates were calculated between the original rhythm and athletes' rhythms. Obtained results were given in Results and Discussion part in detail.

MSE (Mean Squared Error) Function

In statistics, MSE function is used as a risk function and this method is commonly used. Also, this function is corresponded to the expected value of the squared error loss or quadratic loss[15]. The difference occurs because of randomness or the estimator doesn't account for information that could produce a more accurate estimate[16]. In this work, this function is used for calculating the approximation-similarity rates between the original rhythm pattern and participants' rhythm repetitions.

RESULTS AND DISCUSSION

For this study, physical characteristics of test subjects (age, height, weight, body mass index (BMI) and age of

sports) were given in Table-1, respectively.

	MINIMUM	MAXIMUM	AVERAGE	STANDARD DEVIATION
Age (Year)	18	27	21.049	1.50
Height (cm)	165,00	208,00	188,55	6,42
Weight (kg)	60,0	100,00	77,28	6,21
Body Mass Index	21,13	27,41	24,1592	1,6174
Age of Sports	2,00	18,00	6,80	6,0

Table-1: Physical Characteristics of Test Subjects

For this study, the statistical analysis of the data was performed in accordance with the flowchart which was shown in Figure-2.

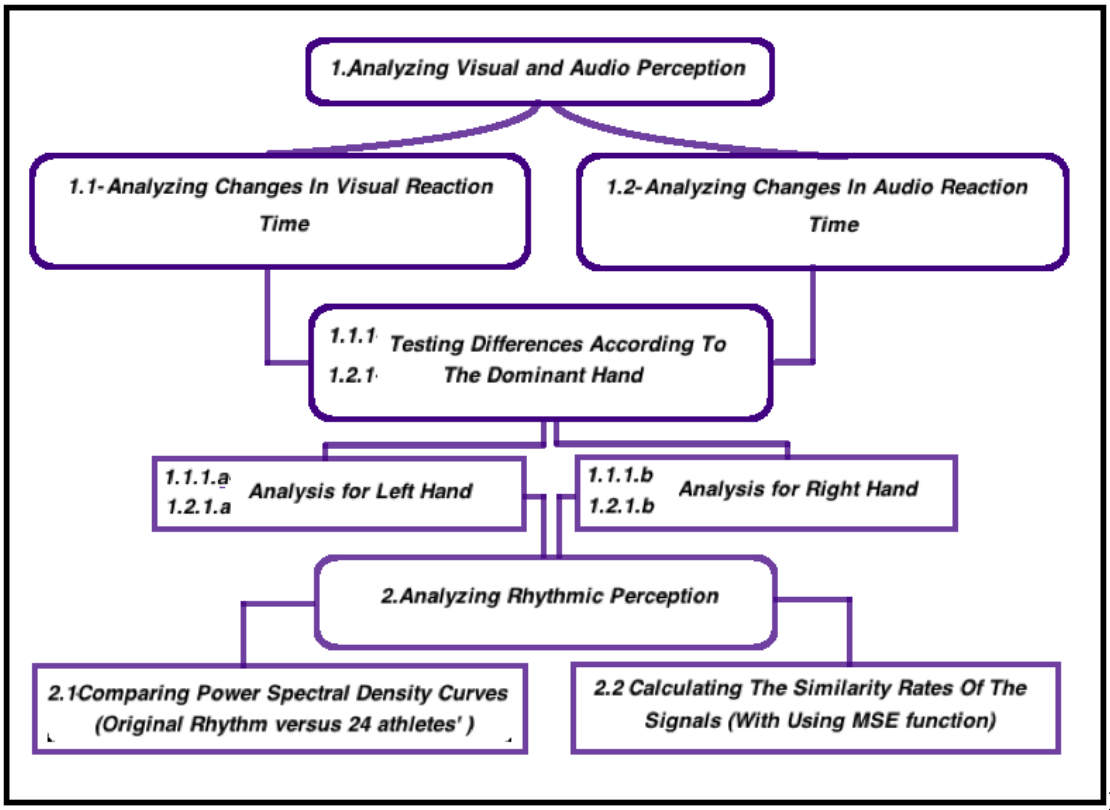


Figure-2: Flowchart of Statistical Analysis Process

1. Analyzing Visual and Audio Perception

1.1- Analyzing Changes In Visual Reaction Time

In this stage, changes and differences in visual reaction times which were obtained from 24 participants in the silent environment were analyzed in detail.

1.1.1- Testing Differences According To The Dominant Hand For Visual Reaction Time

In the first stage, in the silent environment, visual reaction time results were tested and compared in terms of right and left hands for 24 participants. Differences between dominant hands for all athletes were analyzed with "Significant Test".

1.1.1.a- Analysis for Left Hand

When the confidence value was at the percentage of 95%, variance analysis were performed and results were obtained as f=1,166; p=0,255>0.05. At the end of this analysis, no statistically significant relationship was found between visual reaction time and left hand.

1.1.1.b- Analysis for Right Hand

For repeated measurements, when variance analysis were performed at 95% confidence level, for right hand, no difference was observed in visual reaction time for right hand (f=-2,403; p=0,065>0.05).

In the first stage of the analysis, in the silent environment, no significant relationship was obtained between visual reaction time measurements and right or left hand.

1.2- Analyzing Changes In Audio Reaction Time

In this stage, differences in audio reaction times which were obtained from 24 participants in the silent environment were analyzed in detail.

1.2.1- Testing Differences According To The Dominant Hand For Audio Reaction Time

In the second stage, in the silent environment, audio reaction time data were tested and compared in terms of right and left hands for 24 participants. Differences between dominant hands for all participants were analyzed with "Descriptives" and "Significant Test".

1.2.1.a- Analysis for Left Hand

For the measurements, when variance analysis were performed at 95% confidence level, no difference was observed in audio reaction time for left hand (f=1,044; p=0,141>0.05).

1.2.1.b- Analysis for Right Hand

When detailed variance analysis were done on the repeated measurements, it was seen that **a significant correlation was found between audio reaction times and right hand (f=-2,743; p=0,0025<0.05).**

In the second stage of the analysis, in the silent environment, audio reaction time measurements were more successful with the right hand, also when using right hand, smaller audio reaction values were obtained from measurements.
In this stage, finally, when visual and audio reaction data were compared in each other with using Variance Analysis and Bonferonni Test, for 24 participants, it was observed that left hand was more dominant in the audio reaction time measurements and when using left hand, reactions were taken quickly and less time was passed to obtain the results (f=-1,803; p=0,013<0.05).

2. Analyzing Rhythmic Perception

In this part, original rhythm pattern and rhythm repetitions which belonged to 24 athletes were compared in the MATLAB interface and some comparisons and approximation-similarity analysis were done clearly.

2.1- Comparing Power Spectral Density (PSD) Curves

First of all, for 25 rhythm recordings, in MATLAB environment, power spectral density curves were obtained at 95% confidence level. At this level, generally, signals which were in the time domain were transformed to the frequency domain. To show visually, curves which belonged to the four random participants were given in Figure-3. In these curves, the horizontal axis showed frequency (Hz) values and the vertical axis showed power frequency (dB/Hz) values, respectively.

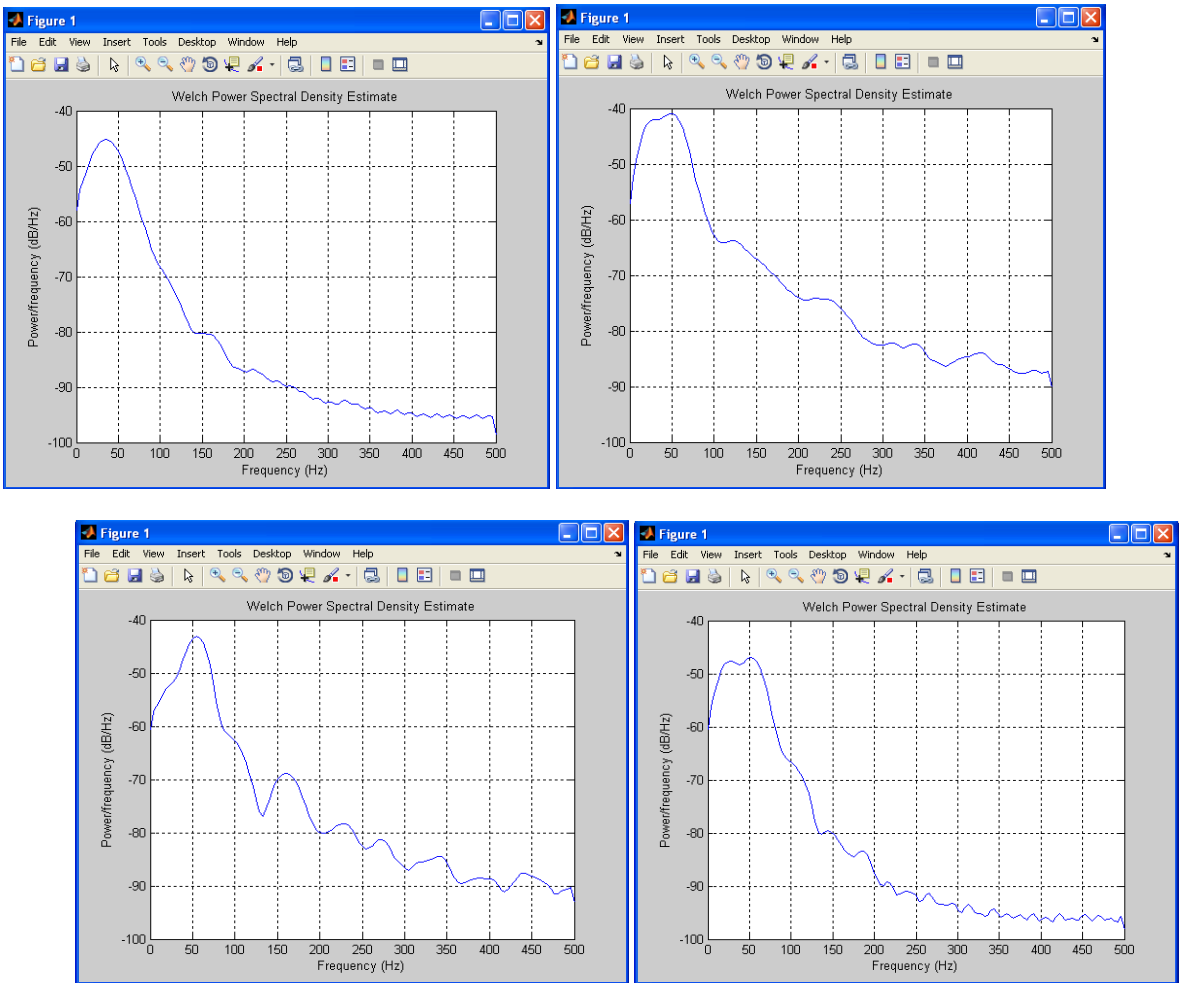
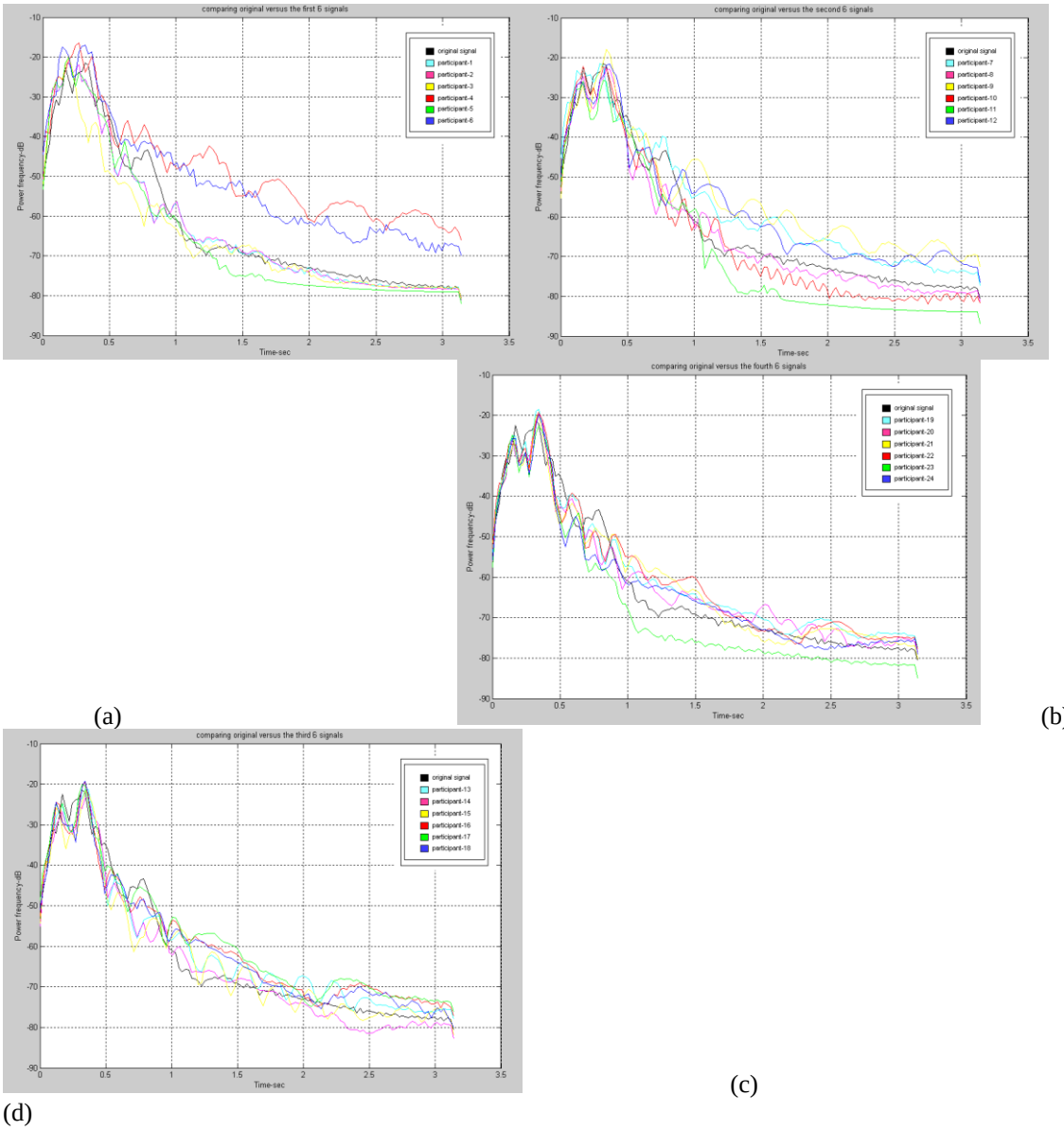


Figure-3: PSD curves for 4 random athletes

When PSD curves were compared in detail, totally, 25 signals were tried to be given in an only one graph, but to reduce confusion and in order to improve clarity, 24 participants' signals were separated to 4 graphs and each of the graphs was consisted from the original rhythm pattern's signal and 6 participants' signals. With fitting method, 4 graphs were rearranged at ±1.50 dB boundary condition. Obtained results were presented in Figure-4.



(a) (b) (c) (d)

Figure-4 (a, b, c, d): Representing the original rhythm's and 24 subjects' curves in the frequency domain with using multiple imaging and fitting methods

When the curves which were given in Figure-4 were analyzed, participants who were close to the original rhythm at ±1.50 dB boundary condition had shorter visual reaction time values. As a result, athletes who had better audio reaction perception had better rhythmic perception. Generally, audio reaction measurement and rhythm perception were related to the brain's auditory region, so a correlation was found between them.

2.1- Calculating Similarity Rates Of The Signals With MSE (Mean Squared Error) Function

Secondly, participants' curves were analyzed with the MSE function to examine approximation rates for all signals. Generally, MSE was an error function and for this work, minimum results were taken as the optimum results. According to this, participants who had minimum MSE values were accepted to close to the original rhythm.

In Table-2, original rhythm's PSD signal was plotted as black in 4 graphs and the color distribution of all participants and audio-visual reaction (A/V) in which one was better were given in detail.

Subject ranking-Color (Fig-3a)	A/V	Subject ranking-Color (Fig-3b)	A/V	Subject ranking-Color (Fig-3c)	A/V	Subject ranking-Color (Fig-3d)	A/V
P1-cyan	audio	P7-cyan	audio	P13-cyan	audio	P19-cyan	audio
P2-magenta	audio	P8-magenta	audio	P14-magenta	audio	P20-magenta	visual
P3-yellow	audio	P9-yellow	visual	P15-yellow	audio	P21-yellow	audio
P4-red	audio	P10-red	visual	P16-red	audio	P22-red	audio
P5-green	audio	P11-green	audio	P17-green	audio	P23-green	audio
P6-blue	visual	P12-blue	audio	P18-blue	audio	P24-blue	audio

Table-2: PSD curves' color distribution and Audio and Visual performances

At the end of the statistical calculations, approximation results for 24 participants were given in Table-3.

Subject ranking-Color (Fig-3a)	A/V	Subject ranking-Color (Fig-3b)	A/V	Subject ranking-Color (Fig-3c)	A/V	Subject ranking-Color (Fig-3d)	A/V
P1-cyan	5,012	P7-cyan	7,441	P13-cyan	5,471	P19-cyan	8,612
P2-magenta	5,762	P8-magenta	4,012	P14-magenta	2,413	P20-magenta	17,19
P3-yellow	6,211	P9-yellow	25,44	P15-yellow	6,413	P21-yellow	4,234
P4-red	9,853	P10-red	17,39	P16-red	4,456	P22-red	6,176
P5-green	7,981	P11-green	6,417	P17-green	8,981	P23-green	9,781
P6-blue	31,35	P12-blue	5,011	P18-blue	2,111	P24-blue	5,121

Table-3: Approximation Results for 24 Participants

CONCLUSION

This study was achieved in the silent environment and 24 students who were in Gazi University Physical Education and Sports School joined to this study and dealing with a sport for many years was the most important criterion for choosing the participants. For this study, generally, in the silent atmosphere, audio and visual reaction times, right-left hand dominance and rhythmic perception were compared in detail (Table-1, Table-2, Table-3).

No statistically significant difference was found between the age and weight parameters among students who were enrolled to this study. During this study, it was seen that, important factors which affected the reaction time response were attention, age, pre-excitation and practicing. Indeed, organic factors, stimulus intensity, motivation and general health factors may affect the reaction time results positively or negatively[17].

In the first stage, visual reaction times were analyzed according to the dominant hand and no significant difference was found between the right-left hand and visual reaction times. For audio reaction times, a significant correlation

was found between the right hand and audio reaction times (f=-2,743; p=0,0025<0.05). Indeed, when visual and audio reaction data were compared in each other, left hand was more dominant in the audio reaction time measurements and when using left hand, reactions were taken quickly and less time was passed to obtain the results (f=-1,803; p=0,013<0.05).

In the second stage, rhythm perception was analyzed for 24 participants. When rhythm records which belonged to the original rhythm and 24 participants were compared in the power spectrum area, it was observed that athletes who were close to the original rhythm at ±1.50 dB boundary condition had shorter visual reaction time values. Also, athletes who had better audio reaction perception had better rhythmic perception. In literature, audio reaction measurement and rhythm perception were related to the brain's auditory region, so athletes, who had an advanced auditory cortex, had better rhythm perception. Also, the significant correlation between audio reaction times and rhythm perception was supported with MSE error data.

If this study is achieved for the different skills of the brain, creative studies can appear[18]. Also, according to the audio-visual reaction and rhythm perception results, if appropriate arrangements are prepared in the educational programs, for every area of music and sports, better improvements can be seen in the performance, attention and power parameters of athletes[19].

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