Effect of Reaction Speed on the Gunshot Hit Rates of Students in Police School

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Abstract: In this study it is aimed to examine the distribution of reaction time in the students of police school and its effect on the gunshot hit rate together with the strength exercise support to be executed for 12 weeks. Research sample is determined as total 42 subjects from male students of police school whose age is in the range of 18 and 20. Before starting the study, hand preferences of the groups were determined by means of Edinburgh Inventory (Oldfield survey). Groups were established within the framework of the study, first group being the experimental group “doing exercises” (n1=21), second group being the control group “not doing exercises” (n2=21). Groups are evaluated within the framework of strength exercises executed in a time period of 12 weeks, 3 days in a week, 1 hour on one day. In the first week before starting exercise program of 12 weeks all tests and measurements (age, height, body weight, resting heart rate measurement, exercising heart rate measurement, right and left hand visual and auditory reaction time test, gunshot hit test) were made, the same tests were repeated and evaluated in the first week following completion of the program. Analysis of reaction time test results differences of the experimental and control groups before and after the exercises is made by Variance analysis, Kruskal Wallis H Test and t test. Analysis of Oldfield preference points was provided by independent two sample t test. Effect of reaction time on the gunshot hit rates is examined by regression analysis. Results are indicated by tabulation. Data was analyzed by using 15.0 software SPSS package program. Importance level is tested as α = 0.05 in the analyses. Height values of the students become prominent as an influential factor in the change of gunshot hit rates. Accordingly, it may be stated that students with short stature are positively affected; exercises executed influenced exercising HR (heart rate) and visual and auditory reaction time measurement values of the students in the experimental group, except weight and resting HR, in a meaningful and significant way, and made a contribution to the reaction development of the students. However, it is seen that reaction time did not cause a statistically meaningful change in the gunshot hit rates.

Key words: Reaction time, exercise, police students.

INTRODUCTION

Change in the functioning of social structure and gradually increasing expectation levels cause also a significant change in the role of police who is in close contact with the society and is responsible for maintaining social security. Qualifications of the police come into prominence especially in the regulation of community relations and communications. Today institutions and organizations of the countries mostly acknowledged or identified by the general quality of the manpower they possess (Fındıklı 2000, Sağlam 2007, Tutkun 2005).

The aim of seizing the grip is to stabilize the barrel at the required point and keep it stabilized until the bullet leaves the barrel. This is achieved by holding the gun and grasping the grip in the correct way. If the fingers, wrists, elbows, shoulders, body and feet are not in accord during trigger squeeze, line of fire shall be destroyed, bullet shall not hit the target but another point. Of course the individual gives direction to the gun. According to the momentum rule in physics, when more than one force is applied to an object, object moves and directs itself in line with the resultant of these forces. Gun is also an object, and it is directed according to the resultant of forces applied onto it by the fingers. In order for the gun not to slip over the target, we should have the control of our arms, wrists and especially fingers. Fingers, hands and arms that are not controlled shall destroy the line of fire. On the point of hand preference while seizing the gun, gun may be held with right or left hand. Ideally both of the hands should have the same adequate control. Holsters are being manufactured for the right side of the body and carried on the right side of the uniforms make the right hand dominant (Fındıklı 2000, Tutkun 2005, Yavuz 1998).

It is known that hand preference may change in line with the genetic, social and cultural factors; however the way and extent to which these factors have influence are not known. Thus, today this situation continues to be a matter in question (Ardila 2001, Bohannon 1997, Çalışkan 1997). It is obvious that training has a significant role in the formation of hand preference. For example, when a child starting to nursery or primary school takes a pencil and tries to write, he/she experiences pressure and is directed by his/her mother, father or teacher. On the other hand there also researches which state that cultural effect does not change the hand preference (Gündoğan 2005, İncel 2002). Since hand preference gives an important clue about the functional

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asymmetry of the brain, those making research on this subject suggest determination of hand preference as a practical method. Various surveys are prepared with this purpose (Bishop 1989, Hossain 1990, İncel 2002). It is informed by Bishop that the scores determined by the surveys are reliable (Bishop 1989).

Sound and light are important warnings in the situations necessitating intellectual skills and fast decision making, especially when utilized as a warning signal. Type of sound and light, their frequency and intensity level have influence on the performance in cases especially necessitating voluntary motion in the level of seconds or even milliseconds. Investigating how decision making mechanisms are affected by the sound and light stimuli gives important information about the development of performance. Reaction time (RT) is a measure of decision-making and speed of getting into action, and one of the best ways of obtaining the mentioned information. Reaction time is a hereditary characteristic that determines the time the individual performs the first muscular reaction or action against the stimuli. In other words, reaction time is the time period between the arrival of a signal that bubbles up and is not prioritized and the response to this signal. Different signals may be given to the individual in the measurement method of the reaction time. These signals may be given by sound or light (pistol sound), or by simple mechanic motions (such as penalty kick), or overall complex motions (such as several players attacking). Here time period passes between the moment the warning is heard, seen or felt by the individual and the moment reaction is given us reaction time. Reaction time is an indicative factor in most of the sports, and may be improved by means of regular practices (Hasçelik 1989, Morris 1997).

Just like sports such as arrow, shot put, javelin, discus throw that are apparatus sports played by certain techniques and rules; pistol shooting is an apparatus sports consisting of behavioral pattern that is technically interconnected and should be performed concertedly. The purpose in pistol shooting is direct hit target success just like in sports by means of a conscious and disciplined working, instead of random success. Since success is directly hitting the target, there are some factors that influence the hit rate. Stance, hand-arm strength, shooting skill, gripping the pistol grip, hand preference, hand-eye coordination, breath status, etc. may affect correct and direct hit shooting (Fındıklı 2000, Özer 2001, Sağlam 2007). In this research, positive or negative effects of gripping strength out of the factors mentioned above as one of the most important duties of locomotor functions of hand on the reaction time of hand and arm muscles that shall be developed by the support of strength exercise program, and gunshot hit rates shall be argued.

MATERIAL AND METHOD

*Research Area and Sample:

This research is performed in the Malatya Police School. Research sample is identified as total 42 subjects from male students between ages 18 and 20. Hand preferences of the groups were determined by means of Edinburgh Inventory (Oldfield survey), and evaluated according to (GS) Geschwind score between +100 and -100. Students who are ambidexter were discarded. It was pointed out that they should not take any drugs at least one day before the examination. Subjects who did not have eye, ear and orthopedic problems were subjected to evaluation.

*Data Collection and Laboratory Analyses:

Project is performed by the participation of voluntary students of police school, and groups were established in this scope, experimental group “doing exercise” being the first group (n1=21), and control group “not doing exercise “being the second group (n2=21). Groups are evaluated within the framework of strength exercises made in a time period of 12 weeks, being 1 hour per day, and 3 days in a week. Researchers visited Malatya police vocational high school for 14 weeks, on Mondays, Wednesdays and Fridays in order to execute exercise program, to perform pre-test and final test measurements.

All tests are performed by the researchers, before starting exercise program of 12 weeks, all tests and measurements were made in the first week; and after the completion of the program, the same tests were repeated and evaluated in the following first week.

A- Pre-briefing Works:

In order to determine personal characteristics of the students within the scope of the project, first records of the students were examined, and interviews were made with the administrative personnel, information about the operation of the police school and living conditions and lessons of the students were received. Information was given to the administrative personnel and students about the project to be made.

B- Demographical Information Form:

Demographical information forms were prepared within the scope of Pre-Interview Recognition Tracking Form, and they were evaluated.
C- Test and Measurements Executed:

1- **Age** (As standard, age in the ID card is used),

2- **Height** (Height scale with 0.01 m degree of precision),

3- **Body weight** (Digital platform scale with 0.01 kg degree of precision), Subjects were weighed on the digital platform scale with bare foot and only the shorts (unit/kg). Height (cm) of the subject was measured by having the subject to stand in front of a metal bar affixed to the height scale in a vertical position. Bar was adjusted so that it would be over the head of the subject, and height was measured from the metal bar (cm) (Fleck 1997, Schmidt 1970).

4- **Resting heart rate measurement (HR)** (Erka trade mark blood pressure monitor and stethoscope were used),

5- **Exercising heart rate measurement** (Erka trade mark aneroid blood pressure monitor and stethoscope were used). Heart rate is determined by using stethoscope in this method. Diaphragm of the stethoscope was placed a little under the left chest of the subject in sitting or laying position towards his arm pit, and measurement was done by listening to ‘lab’ and ‘dap’ sounds for 15 seconds. The point regarded is to consider both of the sounds as one beat. The figure obtained after 15 seconds is multiplied by 4 and heart rate in 1 minute is specified. Resting HR was measured before exercise, and exercising HR was measured after exercise.

6- **Visual and auditory reaction time test**: Visual and auditory reaction time measurements were made by Newtest 1000 device. The section of Newtest 1000 device that shall be in front of the subject is placed 10 cm away from the table, and subject is asked to place his dominant hand onto the table while he is sitting up straight on a chair. When one of the sound or light stimuli is provided together with the “ready” command, he is asked to press the buttons in line with the stimuli as soon as possible. Results were recorded to the result form prepared previously. 10 trials against sound and light stimuli were made with each subject. First 5 measurements were left out of assessment; arithmetic mean of the results obtained from the last 5 stimuli is accepted as the reaction time. Results are stated in terms of Milliseconds (ms).

7- **Hand preference measurement** (Edinburgh Inventory – Oldfield survey)

<table>
<thead>
<tr>
<th>QUESTIONS</th>
<th>Continually left hand -10 points</th>
<th>Generally left hand -5 points</th>
<th>Two hands 0 point</th>
<th>Generally right hand +5 points</th>
<th>Continually right hand +10 points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Writing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2- Drawing picture</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>3- Throwing ball or stone</td>
<td></td>
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<tr>
<td>4- Hand holding the scissors</td>
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<tr>
<td>5- Hand holding the tooth brush</td>
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</tr>
<tr>
<td>6- Hand holding the knife when cutting bread</td>
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<tr>
<td>7- Holding fork (without using knife)</td>
<td></td>
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<tr>
<td>8- Hand holding hammer when pounding nail</td>
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<tr>
<td>9- Hand holding matchstick when striking the match</td>
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<tr>
<td>10- Hand holding the cap when opening bottle-can</td>
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<tr>
<td>TOTAL</td>
<td></td>
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</tr>
</tbody>
</table>

Evaluation is made for 5 groups being “continually left hand”, “generally left hand”, “both hands”, “generally right hand” and “continually right hand”. Respectively -10, -5, 0, +5 and +10 points are given for each answer. Geschwind score is found between +100 and -100. Negative score is in favor of left handedness and positive score is in favor of right handedness.

Thus, hand preference score is evaluated as follows:

- Between -80 and -100, strong left hand,
- Between -20 and -75, weak left hand,
- Between -15 and +15 ambidexter,
- Between +20 and +75 weak right handed,
- Between +80 and +100 strong right handed (Gündoğan 2007, Gündoğan 2005, Oldfield 1971).

8- **Gunshot hit rate** (Target sheet, gun, bullet were used)

On foot gunnery with single hand was used as the gunshot technique and position. Competition of firearms and air guns is made with single hand. First of whole pistol grip should be seized firmly. Thumb must lay free on the grip; it should not apply pressure on the grip. There should be a small gap between the index finder that pulls the trigger and grip. A paper tape should pass between the index finger and the grip easily. Pistol, wrist, arm and eye should be in alignment like a line. Arm must be extended forwards fully, however grip should not be compressed too much. Stance of the body is important. If the shooter is right handed, he takes the target on his right and opens his feet in shoulder width, and body weight is distributed equally on the two feet. An angle of 130-140 degrees is formed between the line of fire and line passing in front of the toes. Gun is raised to the
target. Free hand is placed onto the belt, thus decrease in the oscillation is provided. Now shooter is ready for
shot, hand-eye coordination is provided, sight is aimed and shoot is realized. 5 shots were made in 25
seconds by on foot gunnery method with single hand to the target sheet at a distance of 10 meters, and points of
5 shots were collected from the target sheet and evaluated (Özer 2001, Sağlam 2007, Turkish Shooting and

* Implementation of the Exercise Program:

All equipments and apparatus necessary to initiate the exercise program and test applications were prepared
and assembled in the indoor sports hall of Malatya Police School in the section allocated for the study.

In the exercise program of 12 weeks consisting of biomotoric strength activities;

Intensity (severity) was calculated by Karvonen formula by taking into consideration maximum heart rate
that can be reached according to the formula (Maximum Heart Rate (MHR) = 220-age) depending on the
maximal heart rate of the participant (Evcik 2001, Motfat 1996).

\[
\text{Target Heart Rate} = (\text{MHR} - \text{Resting Heart Rate}) \times (\% 80) + \text{Resting Heart Rate}
\]

Time period of each exercise session consisted of heating up (5-10 minutes), main section (30-40 minutes)
and stretching-cooling (5-10 minutes) stages. Total duration that was initially 40 minutes (including heating up
and cooling stages) was increased for 10 minutes (main section) in the beginning of the 5th and 9th weeks.
Isometric, isotonic, flexibility (mobility) and stretching exercises were made in the heating up and cooling
sections of the exercise aiming at upper extremity hand and arm muscles, and big muscle groups including waist
region in order to avoid or minimize probable articular and muscular problems that may be encountered in the
following days of the regular and planned exercise period. In the main section, shoulder press, leg extension,
chest press, dips (push in), dumbbell shoulder press, overhead Triceps extension, Biceps barbell curl exercise,
at pull down, long pull, level abdominal, leg raising exercises, and fitness exercises were made with 6
repetitions and in 3 sets. Strength activities by using chromium twisting instrument that develops hand claws
and arm muscles and pressing instrument that strengthens hands, wrists; straight and reverse pull-up exercise on
the gymnastic mat, movements on the horizontal bar, push-up exercises again on the gymnastic mat were made
with 6 repetitions in 3 sets. Exercise sessions were made every other day, 3 days in a week that were previously
determined for 12 weeks, daily exercise duration was 1 hour, main section being with 6 repetitions in 3 sets.
Resting time of 1 minute between the sets and 2 minutes between the exercises were given (Fleck 1997, Schmidt
1970).

* Experiment Plan:

<table>
<thead>
<tr>
<th>Groups and hours</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
</tr>
</thead>
<tbody>
<tr>
<td>N1=21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experiment group</td>
<td>Exercise hour</td>
<td>Exercise hour</td>
<td>Exercise hour</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N2=21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control group</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
</tr>
</tbody>
</table>

Weekly working hours of the researchers was total 3 hours, being 1 hour on Mondays, Wednesdays and
Fridays. Exercise duration was applied as 2 hours, since it would take time to prepare the students, to bring them
to the field, and to repeat all procedures at the end of the exercise.

* Arrangement of Data and Analysis Phase (Statistical Analyses):

In this study students of experimental group and students of control group were subjected to reaction time
tests and measurements results were recorded. Gunshot tests of 5 shots were performed before the exercises,
and scoring was made according to the hit rate and measurement results were recorded. Then, 21 students of
experimental group were subjected to exercise program. Again reaction time tests were applied for experimental
and control groups after the exercises, and their measurements after exercises were noted. Then again
experimental and control groups were subjected to gunshot application of 5 shots and their hit rates were
recorded. Oldfield hand preference survey was implemented to determine the dominant hand preference of the
students in the experimental and control groups, and scoring was made in line with the survey results and
Oldfield hand preference scoring results were recorded. Demographic features and reaction time test results of
the students were obtained. Normality control of the data was provided. End-observation and loss-observation
controls were provided. Reaction time test results variance analyses of the experimental and control groups
before and after the exercise program were made by Variance analyses, Kruskal Wallis H Test and t test.
Analysis of Oldfield hand preference scores was made by independent two sample t test. The effect of reaction
time on the gunshot hit rate was examined by regression analysis. Results are indicated in the form of a table.
Data was analyzed by utilizing 15.0 software SPSS package program. Significance level was tested as \( \alpha=0.05 \) in
the analyses.
Findings:

### Table 1: Distribution of Oldfield Hand Preference Scores

<table>
<thead>
<tr>
<th>Variables</th>
<th>Experimental Group (n=21)</th>
<th>Control Group (n=21)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand Preference Score</td>
<td>$\bar{X}$ ± S.D.</td>
<td>$\bar{X}$ ± S.D.</td>
</tr>
<tr>
<td></td>
<td>87.62±20.73</td>
<td>93.57±13.15</td>
</tr>
</tbody>
</table>

### Table 2: Examination of Differences in Oldfield Hand Preferences With Regard To Groups

<table>
<thead>
<tr>
<th></th>
<th>Average Difference</th>
<th>Test Value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Group - Control Group</td>
<td>-5.95</td>
<td>-0.637a</td>
<td>0.528</td>
</tr>
</tbody>
</table>

*a Independent Two Sample T Test; $\alpha = 0.05$

According to the analyses in Table 1 and 2, difference between the scores of control group and experimental group calculated as a result of the Oldfield hand preference survey, is found meaningless statistically. ($p=0.528$) It is determined that there is not a significant difference between two groups; and students both in experimental and control groups are strongly right handed.

### Table 3: Marginal Table on the Demographical Information of the Participant Students

<table>
<thead>
<tr>
<th>Variables</th>
<th>Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Experimental (n=21)</td>
</tr>
<tr>
<td></td>
<td>Before Exercises</td>
</tr>
<tr>
<td>Age (year) $\bar{X}$ ± S.D.</td>
<td>20.90±1.37</td>
</tr>
<tr>
<td>Height (meter) $\bar{X}$ ± S.D.</td>
<td>1.78±0.05</td>
</tr>
<tr>
<td>Weight (kg) $\bar{X}$ ± S.D.</td>
<td>75.71±8.34</td>
</tr>
<tr>
<td>Resting HR (pulse/min.) $\bar{X}$ ± S.D.</td>
<td>75.62±7.65</td>
</tr>
<tr>
<td>Exercising HR (pulse/min.) $\bar{X}$ ± S.D.</td>
<td>131.62±6.34</td>
</tr>
<tr>
<td>Light Right hand(split sc.) $\bar{X}$ ± S.D.</td>
<td>25.62±1.94</td>
</tr>
<tr>
<td>Light Left hand(split sc.) $\bar{X}$ ± S.D.</td>
<td>27.17±3.24</td>
</tr>
<tr>
<td>Sound Right hand(split sc.) $\bar{X}$ ± S.D.</td>
<td>27.32±2.49</td>
</tr>
<tr>
<td>Sound Left hand(split sc.) $\bar{X}$ ± S.D.</td>
<td>28.97±2.37</td>
</tr>
</tbody>
</table>

In the analysis given in Table 3, Age, Height, Weight, Resting HR, Exercising HR, Light Right hand, Light Left hand, Sound Right hand, and Sound Left hand were statistically compared. It was found that there was a significant difference between groups in terms of some variables such as age, height, weight, resting HR, and exercising HR, but not in terms of others. The findings suggest that there is a significant difference in the level of the gunshots hit rates between the experimental group and the control group before and after the exercises.

### Table 4: Average Level of the Gunshot Hit Rate Scores of the Students

<table>
<thead>
<tr>
<th>Variables</th>
<th>Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Experimental (n=21)</td>
</tr>
<tr>
<td></td>
<td>Before Exercises</td>
</tr>
<tr>
<td>Total of 5 Gunshot Hit scores $\bar{X}$ ± S.D.</td>
<td>38.00±4.92</td>
</tr>
</tbody>
</table>

In the analysis given in Table 4, total hit rate scores of 5 gunshots before and after the exercises were obtained. According to this analysis, average of 5 gunshot scores of the students in the experimental group was found as 38.00 before the exercises; and this average was obtained as 45.81 after the exercises. On the other hand, average of total 5 gunshot scores of the students in the control group was found as 38.67 before the exercises, and average of total gunshot hit scores was obtained as 40.19 after the exercises.
In the analysis given in Table 5, measurements of the students in the experimental and control groups were measured before and after the exercises. No change is observed in the age and height measurements of the experimental and control groups before and after the exercises. According to this table weight differences of the students in the experimental group who joined the exercise program before and after the exercises are found statistically meaningless (p=0.428). It is determined that exercise program was not effective in weight reduction statistically, however as a positive result, weight loss was about 2.047 kg. Weight differences of the students in the control group before and after the exercises are found statistically meaningless (p=0.981). It is determined that there was approximately 0.476 kg increase between the measurements of students in the control group.

Resting heart rates (HR) of students in the experimental group who were included in the exercise program were compared before and after the exercises. According to this analysis, resting HR differences of students attending exercise program in the experimental group before and after the exercises were found statistically meaningless (p=0.060). It is determined that exercise program was not influential on the decline of resting HR, however it cause only a reduction of 4.19 pulse/min. as a positive effect. Resting HR differences of students in the control group were found statistically meaningless (p=0.851). It is determined that students in the control group experienced an increase of approximately 0.619 pulse/min. among the two measurements.

Exercising HR of students in the experimental group who were included in the exercise program were compared before and after the exercises. According to this analysis, exercising HR differences of students participating exercise program in the experimental group were found meaningful (p=0.023). It is specified that exercise program is efficient in reducing exercising HR of the students, and that it reduced HR approximately 4.047 pulse/minute. Differences in the exercising HR of the students in the control group are found statistically meaningless (p=0.897). Reduction of approximately 0.476 pulse/minute is determined between the measurements of before and after exercising HR of the students in the control group.

Right hand visual reaction time measurement values of the students in the experimental group who participated in the exercise program were compared before and after the exercises. According to this analysis, light reaction time differences of students attending exercise program in the experimental group are found statistically meaningful (p=0.001*). It is determined that exercise program was effective on the right hand visual reaction time of the students in the exercise program in terms of reacting more speedily to light, and that it provided about 2.91 split seconds of speeding.

Right hand visual reaction time differences of the students in the control group between before and after measurements were found statistically meaningless (p=0.549). It is determined that students in the control group have experienced about 0.49 split second of slowing down.
Left hand visual reaction time measurement values of the students in the experimental group who participated in the exercise program were compared before and after the exercises. According to this analysis, light reaction time differences of students attending exercise program in the experimental group are found statistically meaningful ($p<0.001$). It is determined that exercise program was effective on the left hand visual reaction time of the students in the exercise program in terms of reacting more speedily to light, and that it provided about 3.19 split seconds of speeding.

Left hand visual reaction time differences of the students in the control group between before and after measurements were found statistically meaningless ($p=0.315$). It is determined that students in the control group have experienced about 1.61 split second of slowing down between two measurements in terms of reaction time.

Right hand auditory reaction time measurement values of the students in the experimental group who participated in the exercise program were compared before and after the exercises. According to this analysis, auditory reaction time differences of students attending exercise program in the experimental group are found statistically meaningful ($p<0.001$). It is determined that exercise program was effective on the right hand auditory reaction time of the students in the exercise program in terms of reacting more speedily to the sound, and that it provided about 2.95 split seconds of speeding.

Right hand auditory reaction time differences of the students in the control group between before and after measurements were found statistically meaningless ($p=0.811$). It is determined that students in the control group have experienced about 0.26 split second of speeding between two measurements.

Left hand auditory reaction time measurement values of the students in the experimental group who participated in the exercise program were compared before and after the exercises. According to this analysis, auditory reaction time differences of students attending exercise program in the experimental group are found statistically meaningful ($p<0.001$). It is determined that exercise program was effective on both hand auditory reaction time of the students in the exercise program in terms of reacting more speedily to sound, and that it provided about 3.62 split seconds of speeding.

Right hand auditory reaction time differences of the students in the control group between before and after measurements were found statistically meaningless ($p=0.897$). It is determined that students in the control group have experienced about 0.15 split second of speeding between two measurements.

As a conclusion, it may be stated that exercises executed have substantially and markedly influenced exercising HR and visual and auditory reaction time measurement values of students in the experimental group, except their weights and resting HR, and have contributed to the development of students’ reaction.

Hit scores of 5 gunshots made by the students attending exercise program in the experimental group before and after the exercises were summed up and their measurement values are compared. According to this analysis, differences in the gunshot hit scores of the students in the experimental group before and after the exercises are found statistically meaningful ($p<0.001$). It is identified that exercise program is efficient in terms of increasing the gunshot hit rates of the students, and it has provided an increase of approximately 7.81 points.

Differences in the total gunshot hit scores of students in the control group achieved by 5 gunshots before and after the exercises are found statistically meaningless ($p=0.361$). An increase of 1.52 points is determined between two measurements of the students in the control group. However this increase is found statistically meaningless.

As a result of the analysis made, it draws attention that exercises cause the biggest change by the increase in the gunshot hit rates. It is observed that the least impact is achieved in the weight change.

Table 6: Examining Effect of Reaction Time Tests of Experimental Group on the Gunshot Hit Rates

<table>
<thead>
<tr>
<th>Variables</th>
<th>Experimental Group (n=21)</th>
<th>Before Exercises</th>
<th>After Exercises</th>
<th>$p^{*}$</th>
<th>$t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (year)</td>
<td>0.274</td>
<td>0.512</td>
<td>0.150</td>
<td>0.723</td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td>-0.448</td>
<td>0.266</td>
<td>-0.752</td>
<td>0.031</td>
<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>-0.153</td>
<td>0.717</td>
<td>-0.358</td>
<td>0.384</td>
<td></td>
</tr>
<tr>
<td>Resting Heart Rate (pulse/min)</td>
<td>-0.578</td>
<td>0.134</td>
<td>0.239</td>
<td>0.569</td>
<td></td>
</tr>
<tr>
<td>Exercising Heart Rate (pulse/min)</td>
<td>-0.117</td>
<td>0.782</td>
<td>-0.146</td>
<td>0.731</td>
<td></td>
</tr>
<tr>
<td>Light Right Reaction (split sec.)</td>
<td>-0.582</td>
<td>0.130</td>
<td>-0.119</td>
<td>0.980</td>
<td></td>
</tr>
<tr>
<td>Light Left Reaction (split sec.)</td>
<td>0.527</td>
<td>0.180</td>
<td>-0.460</td>
<td>0.252</td>
<td></td>
</tr>
<tr>
<td>Sound Right Reaction (split sec.)</td>
<td>-0.602</td>
<td>0.114</td>
<td>0.208</td>
<td>0.622</td>
<td></td>
</tr>
<tr>
<td>Sound Left Reaction (split sec.)</td>
<td>-0.132</td>
<td>0.755</td>
<td>0.029</td>
<td>0.945</td>
<td></td>
</tr>
</tbody>
</table>

$^{*}$Regression Analysis, $\alpha = 0.05$; Effect is statistically meaningful; $r = correlation$

In the analysis given in Table 6, impact of reaction time tests of the experimental group on the gunshot hit rates is compared. It is seen that none of the reaction time test has an influence on the gunshot hit rates by itself before the exercises. However, it is specified that height factor has a significant effect on change of the gunshot hit rates by itself after the exercises.
reaction time decreases, gunshot hit rate increases. On the other hand, it is observed that none of the reaction variable on the gunshot hit rates by itself is found statistically meaningful. It is determined that as the left hand in the control group is investigated. As a result of the analysis, the effect of left hand auditory reaction time on the gunshot hit rates.

As a result of the analysis made in Table 8, the effect of hand preference of students in the experimental group on the gunshot hit rates before and after the exercises is found statistically meaningless. The value before exercises is found as p=0.187 and after exercises as p=0.956. The effect of hand preference of students in the control group on the gunshot hit rates before and after the exercises is found statistically meaningless. These values are found as p=0.233 before the exercises and as p=0.420 after the exercises. Thus, it can be stated that both of the groups are strongly right handed, and hand preference does not have a statistically meaningful effect on the gunshot hit rates.

**Discussion And Conclusion:**

It cannot be previously forecasted when the police shall be under attacks or when they should use their guns during their duties motorized-on foot or patrolling, on-spot duty or in an operation medium. It is remarkable that administrators do not give the required importance to the shooting drills even though many soldiers become martyr, veteran, and get wounded during their duties. For this reason, a training system is required which shall directed shot becomes apparent in this training period (Fındıklı 2000, Tutkun 2005).

It is important to feel commanding the pistol with hand strength by seizing the grip during shooting. This command of shooter directly increases his self-confidence and his shots shall be more on target. Thus a good shooting technique and hit rate shall be achieved. Seizing strength of the hand is an objective component of upper extremity functional integrity and also it is an indicator of the muscle strength of the individual. For human beings, to be able to use the left hand or both hands (ambidexter) can be an important advantage. When it is considered that right hand is used in most of the fields in the rate of 80-90%, and almost all defense and attack strategies are planned in this way; to be able to use both hands may be useful in a tactical viewpoint, and this situation may cause significant benefits for those who are left handed or ambidexter (Özdemir 2004, Tutkun 2005, Yavuz 1998).

This study is realized with the aim to examine distribution of reaction time in the students of police school and its influence on the gunshot hit rate with the support of strength exercises for 12 weeks. It is determined that students both in experimental group (87.62±20.73) and control group (93.57±13.15) are strongly right handed. When the literature is reviewed, it is seen that Geschwind Score averages are found as 81.9±37.7 and 72.4±49.3 for girls, and 68.1±52.9 and 68.1±56.0 for boys in a research performed by Çalışkan et al. (Çalışkan 1997). In the research realized by Gökbel et al., Geschwind Score average and standard deviation are found as 71.4±43.4, 80.5±39.6 and 76.4±49.8 for girls, and 65.7±39.6, 65.8±54.6 and 77.6±34.2 for boys. Ratio of the left-handed girls was 6.19% and ratio of left-handed boys was 6.5% (GS<0) (Gökbel 1992). Our findings are in compliance with the results of studies realized in different regions of our country. On the other hand, ratio of right handedness is determined as 90.84%, use of both hands as 8.90% and ratio of left

**Table 7:** Examining the Impact of Reaction Time Tests of Control Group on the Gunshot Hit Rates

<table>
<thead>
<tr>
<th>Variables</th>
<th>Control Group (n=21)</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before Exercises</td>
<td>After Exercises</td>
<td>Before Exercises</td>
<td>After Exercises</td>
<td></td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>p*</td>
<td>r</td>
<td>R</td>
<td>p*</td>
</tr>
<tr>
<td>Age (year)</td>
<td>-0.464</td>
<td>0.247</td>
<td>-0.558</td>
<td>0.151</td>
<td></td>
</tr>
<tr>
<td>Height (m)</td>
<td>-0.009</td>
<td>0.984</td>
<td>-0.399</td>
<td>0.328</td>
<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>-0.069</td>
<td>0.870</td>
<td>0.151</td>
<td>0.722</td>
<td></td>
</tr>
<tr>
<td>Resting Heart Rate (pulse / min.)</td>
<td>0.149</td>
<td>0.725</td>
<td>0.355</td>
<td>0.418</td>
<td></td>
</tr>
<tr>
<td>Exercising Heart Rate (pulse / min.)</td>
<td>-0.062</td>
<td>0.885</td>
<td>-0.270</td>
<td>0.518</td>
<td></td>
</tr>
<tr>
<td>Light Right Reaction (split sec.)</td>
<td>0.019</td>
<td>0.965</td>
<td>0.303</td>
<td>0.465</td>
<td></td>
</tr>
<tr>
<td>Light Left Reaction (split sec.)</td>
<td>0.676</td>
<td>0.065</td>
<td>0.556</td>
<td>0.152</td>
<td></td>
</tr>
<tr>
<td>Sound Right Reaction (split sec.)</td>
<td>-0.617</td>
<td>0.103</td>
<td>0.159</td>
<td>0.707</td>
<td></td>
</tr>
<tr>
<td>Sound Left Reaction (split sec.)</td>
<td>-0.745</td>
<td>0.034</td>
<td>-0.365</td>
<td>0.354</td>
<td></td>
</tr>
</tbody>
</table>

*Regression Analysis;  α= 0.05; * Effect is statistically meaningful; r = Correlation

**Table 8:** Examining the Impact of Hand Preferences on the Gunshot Hit Rates

<table>
<thead>
<tr>
<th>Variables</th>
<th>Groups</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Experimental (n=21)</td>
<td>Control (n=21)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Before Exercises</td>
<td>After Exercises</td>
<td>Before Exercises</td>
<td>After Exercises</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>p*</td>
<td>P</td>
<td>p</td>
<td></td>
</tr>
<tr>
<td>Effect of Hand Preference on the Gunshot Hit Rates</td>
<td>0.187*</td>
<td>0.956*</td>
<td>0.233*</td>
<td>0.420*</td>
<td></td>
</tr>
</tbody>
</table>

*Regression Analysis; α= 0.05
handedness is specified as 0.26% in a study with 10314 participants in societies where traditional culture is ruling, for example in China. Right hand preference fits for the rate of right handedness in our study. The reason why the left hand preference is so low is explained by other studies made in China that has a traditional culture structure (Guo 1984). For example, the rate of right handed, two handed and left handed students were found respectively as 95.2%, 3.2% and 1.6% in the study realized in Hong Kong university in which hand preference was examined in three groups with the participation of 556 students (n=336 girls, n=220 boys). It is stated that the individuals in this study were manipulated in their childhood for their hand preference. The rate of pressure applied for the hand preference was informed as 4.1% in right-handed students, 88.9% in two handed, and 55.6% in left-handed students (Hossain 1990). This study shows that pressure is applied for hand preference in the traditional culture of the East. Thus, this explains why left hand preference is so low in the studies made in China. It is stated in the western resources that left handedness incidence is 8-10% in the general population (Annett 1970). Tan has found in the research realized in the Turkish community by 1100 subjects whose ages are between 20 and 22 that right handedness is 66.1%, left handedness is 3.4% and double handedness is 30.5%, and that rate of left handedness in males is 5.1 (Tan 1988). Annett has informed that right hand preference in the society is dominant, and incidence of left-handedness is 8-10% in the general population (Annett 1970). Left handedness incidence in males is found as 8.2% in the study realized by Hossain in Hong Kong (Hossain 1990). Perelle has announced left hand preference as 9.5%, and right hand preference as 89.6% in the international study realized with 12000 subjects in 17 countries (Perelle 1994). Hand preference results obtained by our study show similarities with the literature.

To be able to use left hand or both hands (ambidexter) may be a significant advantage for polices. When it is considered that generally right hand is used in the rate of 80-90%, and almost all defense and attack strategies are planned in this way; to be able to use both hands in several cases may be useful for polices in a tactical viewpoint, and this situation may cause significant benefits for those who are left handed or ambidexter. Studies should be performed to determine specifically hand preference prevalence of polices. In our study, no statistical relevance is determined among the groups in terms of right handedness and left handedness. According to our findings, dominant floccules of these students are the left floccules. It is a significant subject open to research whether or not there is a parallelism between the inborn mental abilities of the students and their educational success and accuracy in choice of profession (Oldfield 1971, Tutkun 2005, Yavuz 1998).

There is no statistically meaningful change in the age, height and weight measurements of the experimental and control groups before and after the exercises. It is determined that exercise program is not influential to reduce weight of the students; however it caused a reduction of approximately 2.047 kg in the weight. On the other hand, students in the control group experienced an increase of 0.476 kg in their weights. However these differences are not found statistically meaningful.

Several researches on blood pressure and HR established that exercise decreases the blood pressure and HR (Wilmore 1996). Reaction of HR to exercises is sudden. Pulse rate increases and continues until steady state is reached. Increase in HR is a way of increasing oxygen transmission to muscles and thus blood flow (Hoeger 1991, Wilmore 1996). In a research made by Hoeger, resting HR being less than 59 pulse/min. is defined as perfect, 60-69 pulse/min. as good, 70-79 pulse/min. as reasonable, 80-89 pulse/min. weak and more than 90 pulse/min. very weak (Hoeger 1991). Wilmore et al., have determined a meaningful decrease in the resting HR in the level of p<0.05 after the exercises in a period of 20 weeks in their study. They have revealed at the end of the study that endurance activities in medium and high density caused decrease in the resting pulse (Wilmore 1996). Black et al. have realized a similar study. They examined 62 subjects at certain times of the day and found that aerobic exercises have decreased heart rate and blood pressure. They have proved that aerobic exercises present in medium severity and high density caused decrease in the resting pulse (Black 2004). Resting HR differences of the students in experimental and control groups of our study before and after the exercises are not found statistically meaningful (p=0.060, p=0.851). It is determined that exercise program is efficient in decreasing the resting HR of the students, and it decreased HR approximately 4.047 pulse/minute. About 0.476 pulse/minute decreases is determined in the exercising HR of students in the control group before and after the exercises, however this is not considered as a meaningful decrease.

Measurement of reaction time is very important especially for short distance races or at the start of swimmers (Sevim 2000). Reaction time should be considered as a part of the other activities. Success in the most of the fast motions is dependent on the speeding up of the athlete with regard to the medium or opponent. These are executed when athlete decides what to do and starts to move. Such activities may also be observed in
boxing, football or car races, because reaction time is considered as the basic component of most of the skills. (Psikomotor Gelisim 2007).

In various studies it is indicated that reaction time may be improved by means of regular practices. It is stated that reaction time against visual stimuli is less for exercised athletes in comparison to unexercised athletes (Agopyan 1993, Sevim 2000).

It is stated that reactions given to auditory stimuli are shorter than the reactions given to visual stimuli (Üstdal 1998). In another study it is determined that development of 6.9% in the simple auditory reaction time and 7.7% in the visual reaction time of adult sprinters is achieved after speed practices of eight weeks. It is reported in many studies that multi-perspective factors are influential on the psychological condition and decision-making skill of the athletes, and reaction time as one of these factors can be improved by means of practices (Sevim 2000, Üstdal 1998).

There are factors affecting reaction time positively or negatively. Doing exercises is one of the factors affecting the reaction time in a positive way. Numerous studies are realized on this subject, as a result it is established that reaction time of athletes is prominently faster than those who are not athletes (Freeman 1933, Morris 1997, Morris 1994).

In the study performed by Sherwood and Selder in which reaction times of athletes of long-distance race and sedentary group are compared, it is indicated that reaction times of athletes are shorter (Sherwood 1979).

Welford has indicated that students physically in good condition have faster reaction times (Welford 1980).

Hasçelik et al. have measured reaction times of male volleyball players with average age of 18.5 years after the warming-up and strength practices of eight weeks, and reported that both simple visual reaction times and selective visual reaction times improved after the training of 8 weeks. Researchers state that reaction time improves together with the age in men and women, and men have a 3%-5% better reaction time in the comparison to women (Hasçelik 1989).

Morris and Keen have examined the effect of exercise in medium intensity that shall cause fatigue on the simple reaction time, and established that simple reaction time is expressively slower during the maximal exercises (Morris 1994).

Baylor and Spirudo have reported that reaction time of females with ages between 48 and 63 and making aerobic exercise for 5 years is shorter in comparison to sedentary persons (Baylor 1988).

Davranche and et al. indicated that reaction time of individuals whose activity level is high, is faster than those whose physical activity level is low. They concluded that exercises accelerated the reaction time by increasing the stimulation (Davranche 2006).

Welford, Broadbelt, Freeman have stated that reaction time deteriorated when the individual is under a lot of stress or too comfortable, and reaction time increases controlling skill in most of the sports activities (Broadbelt 1996, Freeman 1933, Welford 1980).

However, reaction time values of our research groups are slightly higher than the values in the literature. Reason may be arising from gunshot courses polices attend and their habit of holding pistols, just as it is true for fencers. When we examine the results above, it is seen that reaction times of athletes in the same sports branch may have fairly different values.

As it is supported by the literature, it is established in our research that exercises executed have influenced the reaction time measurement values in a meaningful and significant way except body weight and resting HR values of the students in the experimental group, and that it contributed to the improvement of their reaction times. These increases are found meaningful positively in direct proportion with the literature results (p<0.001).

Just like sports such as arrow, shot put, javelin, discus throw that are apparatus sports played by certain techniques and rules; pistol shooting is an apparatus sports consisting of behavioral pattern that is technically interconnected and should be performed concerted. The purpose in pistol shooting is direct hit target success just like in sports by means of a conscious and disciplined working, instead of random success. Since success is directly hitting the target, there are some factors that influence the hit rate. Stance, hand-arm strength, shooting skill, grabbing the pistol grip, hand preference, hand-eye coordination, breath status, etc. may affect correct and direct hit shooting (Çalışkan 1997, Reikeras 1983).

The purpose of physical education in shooting sports is to acquire a condition that will endure competition rules in bodily and mental respects. A shooter having a good physical condition has developed his reflexes, controls his muscle strength and whole body better, thus has a higher gunshot hit rate, and develops this success consistently as days pass. Exercises that strengthen the muscles, develop breathing and circulatory system, increase the body elasticity are overstressed subjects of physical education program of shooting (Fındıklı 2000, Yavuz 1998).

The aim in grasping the grip is to stabilize the barrel at the required point, and to maintain this position until the bullet leaves the barrel. This is achieved by holding the pistol and grasping the grip in an accurate way. If fingers, wrist, elbow, shoulder, body and feet are not in accord when the trigger is squeezed, bullet shall not hit the target aimed. Of course, individual gives direction to the pistol. According to the momentum rule in physics, when more than one force is applied to an object, object moves and is directed in the direction of
resultant of these forces. Pistol is also an object, and is directed according to the resultant of forces applied on it by the fingers. For the pistol not to slip over the target, dominance of our arm, wrist and especially our fingers should be achieved. Uncontrolled fingers, hand and arm shall destroy the line of fire during trigger squeeze. Pistol may be held by right or left hand as the hand preference. Dominance of both hands at the same strength is an ideal situation. Holsters are being manufactured for the right side of the body and carried on the right side of the uniforms make the right hand dominant (Fındıklı 2000, Tutkun 2005, Yavuz 1998).

Also in our study, dominant hand is determined to be statistically strong right hand among both of the groups. 5 gunshots hit scores of students of experimental group included into exercise program and students of control group not included into the exercise program were recorded before and after exercises, and they were compared statistically. At the end of 12 weeks, a change of 1.52 points is achieved in the control group, and this change is found to be statistically meaningless. An increase of 7.81 points is obtained in the experimental group, and this increase is considered as a statistically meaningful increase (p<0.001).

As a result, it is observed that exercise program have achieved the biggest change in the students of experimental group with the increase in gunshot hit rates. Minimum effect of exercise is determined in the weight change. In our study, height of the students is specified as a fairly influential factor affecting the gunshot hit rates. Accordingly, it may be stated that short stature of some of the students influences their gunshot hit rates in a positive way.

Consequentially, statistically significant results acquired by strength exercise program executed for experimental group on the visual and auditory reaction times and gunshot rates show parallelism with the accessible literature. However, it is seen that reaction time does not have a statistically significant effect on the gunshot rates even though it has a great importance in the police work. Implementation of these tests in different time periods for police athletes in different sports branches and with different sporting durations may give different results. Since there is limited literature information on reaction time and gunshot hit rates, such scientific studies are needed to determine advantages or disadvantages provided in the gunshot hit rates of the polices by specifying visual and auditory reaction times of students of police school and by performing strength exercise tests as a specific occupational research.

REFERENCES


Turkish Shooting and Hunting Federation; Shooting, Hunting and Paintball, 2007. Competition Instructions Board of Directors Decision Date and Number Implementation, 25.04.2007.


