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The Effect of a Long-Term Artistic Gymnastic Training on Reaction Time of Male Gymnasts

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ABSTRACT

Since there are variations in the reaction times of athletes in different sports, the aim of the present study was to evaluate the effectiveness of a specific training program on a simple reaction time of male gymnasts. In this longitudinal study, fourteen adolescent gymnasts (mean age 12.6 ± 2.1 years) were randomly selected to work out for 15 months in the artistic group. Simple reaction time was assessed by visual and auditory tests using computer software. The training resulted in a significant ($P < 0.001$) reduction in visual (0.33 ± 0.047 s vs. 0.30 ± 0.048 s) and auditory reaction time (0.31 ± 0.056 s vs. 0.27 ± 0.038 s). This study suggested an improvement in both reaction time tests over a long time of specialized training program. Artistic gymnasts had overall developed results of the tests that might be derived from exercise induced arousal, concentration and movement complexity in this sport.

Key Words: Artistic Gymnasts, Specific Training, Psychological Tests.

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INTRODUCTION

Reaction time is relevant to the time of stimulus perception and evaluation for response. A reaction to only a single stimulus that is always same and necessitates similar way of response called simple reaction time (1). When there are some possibilities that should be selected during experiment like producing different stimuli requiring a different response, it is called choice reaction time (2). Reaction time (RT) is an extremely sensitive and objective parameter which reflects cognitive and motor function that was used in numerous studies (3). The vision is the slowest of the sensory systems, with an average reaction time between 180 and 200 ms (depending on the task conditions). Auditory reaction time is the next, with mean values between 140 and 160 ms and kinesthetic reaction time is the fastest, averaging between 120 and 140 ms (4).

It is established that arousal induced by exercise promotes alertness to external environmental stimuli in elite athletes (5). Furthermore, physical activity affects reaction time positively (6) and athletes' reaction time is better than that of non-athletes (7). However, there are variations in the reaction times of athletes in different sports (6). Actually scientific literature review indicates no relationship between simple reaction time and other sports (8). In other words, simple reaction abilities have not been improved as a result of long-term practice. The influence of a treadmill running exercise at 95 and 125% of VO₂max on simple and binary-choice reaction time in expert basketball players showed an impairment of simple reaction time under exertion but inversely an improvement of choice reaction time (9). On the contrary exertion had influence, neither on reaction time nor error rate of expert athletes in other sports. No relationship exists between simple reaction time and offensive ability in baseball (10). Comparison of the response of karate athletes and amateur wrestlers to a light stimulus showed no difference between them (11). In contrast, karate athletes with black belts

were faster for hitting a punch bag in response to a sound stimulus than those who were in lower grades (12). In another study, it was indicated that the expert karate athletes were no faster than the novices, while the athletes were more accurate than the novices (13). These experiments almost demonstrate contradictory results about the relationship of different sports and components of reaction times. Very few researches have examined gymnastics athletes to show whether they improve in reaction time tests or not. The purpose of this study was to examine the effect of a long-term specific training on visual and auditory reaction time of male artistic gymnasts aged between 11 and 14 from Iran.

We hypothesized that (a) artistic gymnasts are so much more accustomed to exercise-induced arousal and concentration that they can work well in reaction time tests. To verify this hypothesis, we assessed the effects of gymnastics experience on the ability of reaction time. We also assume that (b) more highly-skilled gymnasts have shorter reaction time due to executing complex elements. To verify this hypothesis, we assessed the effects of skill levels on simple reaction time.

MATERIALS AND METHODS

The study protocol received approval from the ethics committee of the University of Urmia, and it was in accordance with the Declaration of Helsinki (last modified in 2000).

Participants. Fourteen adolescent gymnasts (age 12.6±2.1) were randomly recruited in a specialized artistic training group. They were engaged from two of the most successful teams participating in the Under - 18 national championships. Participants and their parents were entirely informed of the study and provided written consent.

Training Protocol. The daily practice of the artistic gymnasts training program was performed in specific movements on six different apparatuses: floors, pommel horses, still rings, vaults, parallel bars, and high bars.

All the gymnasts trained at least five times a week between 2 and 3.5 hours per day.

Data Collection. Implementation of the investigation was in the normal room with a computer consisted reaction time tests (14). For measuring visual RT, gymnasts were supposed to pay attention to the computer monitor and press bottom as soon as they would see the green color. They also were said to press the bottom immediately after hearing a sound to measure the auditory RT. All gymnasts took part in an instruction session prior the test and it was clear that they understood the essence of the study.

Statistical Analysis. Descriptive statistics (means and 95% confidence intervals) were

performed for all variables. Normal distribution of all variables was checked using the Kolmogorov-Smirnov test. Paired t-test was used to determine the significance difference between the variables before and after artistic gymnasts training. The level of significance was set at $p < 0.05$. SPSS software was used for data analysis.

RESULTS

The changes of visual and sound reaction time after training are shown in Table 1. The taking training resulted in a significant ($P < 0.001$) reduction in visual (0.33 ± 0.047 s vs. 0.30 ± 0.048 s) and auditory reaction time (0.31 ± 0.056 s vs. 0.27 ± 0.038 s).

Table 1. Result of t-test and Descriptive Statistics for Visual Reaction Time (Mean± SD)

Variable	Before training	After training	df	t	p
Visual Reaction Time (s)	0.33 ± 0.047	0.30 ± 0.048	13	5.83	0.001
Sound Reaction Time (s)	0.31 ± 0.056	0.27 ± 0.038	13	4.51	0.001

** : Significant level at $p < 0.01$

DISCUSSION

To our knowledge, this is the first investigation of male athletes' reaction time in artistic gymnastics. This study evaluated the effectiveness of a specific long-term training program on reaction time of adolescent gymnasts. It is declared that no relationship exists between simple reaction time and other sports (10). In other words, simple reaction abilities have not been improved as a result of long-term practice. The influence of a treadmill running exercise at 95 and 125% of VO_{2max} on simple and binary-choice reaction time in expert basketball players who showed an impairment of simple reaction time under exertion but inversely an improvement of choice reaction time (11). Effects of a cycling exercise at 35, 60 and 90% of VO_{2max} on simple and choice reaction time in female physical education students indicated no effect of exertion on reaction time. The results of present study are not consistent with those of other studies in this regard and indicate a significant improvement in both visual and auditory reaction time of artistic

gymnasts after participating almost 15 months in this sport. This improvement is might due to cognitive functioning development that has been supported in previous studies (8, 9). A posteriori analysis showed that expert athletes improved their choice reaction time in team sports at high exertion levels (12). On the contrary, exertion had influence neither on reaction time nor error rate of expert athletes in other sports. These experiments almost demonstrate that choice reaction time tasks are improved as exertion increased in sports which require a decisional activity under high energy expenditure. Indeed gymnastics is not like team sports that require decisional activity; however arousal that is made from exercise promoting alertness to external environmental stimuli in gymnastics athletes (7). Moreover, concentration is one of the most important features of a gymnast for performing dangerous skills with a higher elegance and lower flaw (15). There are six apparatuses in artistic gymnastics and athletes performing almost 800 movements during the 8 to 10 years of their expertise. The bases of all elements that

are conducted in this sport are complexity and gymnasts challenge themselves in daily practice sessions to overcome this characteristic. The vision is the slowest of the sensory systems with an average reaction time between 180 and 200 ms (depending on the task conditions). Auditory reaction time is the next with mean values between 140 and 160 ms and kinesthetic reaction time is the fastest averaging between 120 and 140 ms (4). The results of this study are in line with the previous study and showed slow and fast reaction times in visual and auditory tests respectively (4). We can support the preceding findings that indicate physical activity affects reaction time positively (5) and athlete's reaction time is better than non-athletes (6). Since our athletes participated in high level training programs and performed numerous movements to obtain the improved results of the tests, we can declare that more physical activity

leads to more physical and psychological enhancement. It was encouraging to find that visual and sound reaction time of the artistic gymnasts was affected with specific interventions. This suggests that most aspects of cognitive affairs can be improved in regard to sport performance. These psychological tests should be tested in other events of gymnastics including trampoline and rhythmic gymnastics using both genders as they do not seem to be conducted in previous studies.

CONCLUSION

This study suggested an improvement in visual and auditory reaction time over a 15-months period. Artistic gymnasts had overall developed results of the tests due to some characteristics including exercise induced arousal, concentration and movement complexity in this sport.

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اثر برنامه تمرینی طولانی مدت ژیمناستیک هنری بر زمان واکنش پسران ژیمناست

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چکیده

هدف از این مطالعه، بررسی تأثیر برنامه تمرین تخصصی بر زمان واکنش ساده ورزشکاران مرد ژیمناستیک می‌باشد. در این تحقیق طولی، چهارده ژیمناست نوجوان (میانگین سنی $12/6 \pm 2/1$ سال) بطور تصادفی انتخاب شده و در گروه تمرین تخصصی هنری قرار گرفتند. زمان واکنش ساده توسط تست بصری و شنیداری با استفاده از نرم افزار کامپیوتری مورد ارزیابی قرار گرفت. انجام تمرینات تخصصی منجر به کاهش معنی دار ($p = 0/001$) در زمان واکنش بصری ($S = 0/048 \pm 0/3$ در برابر $S = 0/047 \pm 0/33$) و شنیداری ($S = 0/038 \pm 0/27$ در برابر $S = 0/056 \pm 0/31$) شد. نتایج این تحقیق حاکی از آن است که ورزشکاران در هر دو تست زمان واکنش پیشرفت معناداری را در طی ۱۵ ماه نشان دادند. این پیشرفت در ورزشکاران ژیمناستیک هنری شاید در نتیجه انگیزتگی ناشی از ورزش، تمرکز و پیچیدگی حرکت باشد.

واژگان کلیدی: ژیمناستیک هنری، تمرینات تخصصی، تست‌های روانشناختی.

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