EFFECT OF UNIFORM PLYOMETRIC TRAINING PROGRAMME ON MOTOR FITNESS PARAMETERS OF TEEN-AGE ATHLETES

A SYNOPSIS OF THE THESIS SUBMITTED
TO THE JADAVPUR UNIVERSITY
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY
IN PHYSICAL EDUCATION
FACULTY OF ARTS

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MARCH, 2022

INTRODUCTION

Success in many sports depends heavily upon the athlete's explosive leg power and muscular strength. In jumping, throwing, track and field events, and other activities, the athlete must be able to use strength as quickly and forcefully as possible. This display comes in the form of speed-strength or power (Yeses, & Hatfield 1986). Power represents the amount of work a muscle can produce per unit of time. An increase in power gives the athlete the possibility of improved performance in sports in which the improvement of the speed-strength relationship is sought (Paul, et. al., 2003).

Given the nature of the sport, athletes and sports champions have various needs, priorities, and preferences in terms of physical fitness and mobility status. In other words, all sports courses hold individual requirements in strength, endurance, power, flexibility, and speed, or a combination of them; which vary from one sport to another. Muscle power is an effective parameter to success. Power has defined an ability to do work per unit of time. In physical education, it refers to the maximal force that a muscle generates in the shortest possible time to confront the resistance, it is equal to muscular force or explosive power.

Plyometric practices involve specific muscles in eccentric-concentric movement cycles. The frequency of eccentric (stretching) and concentric (shortening) actions provides higher power than simple concentric action. Elastic energy within the muscle can produce more force. Increased power generation plays an important role in improving sprint running times, which require high explosive power. **Cavagna et al. (1971)** evaluated the amount of force generated during sprint running, from start to end points (9.4 m/s), and found that the peak power out puts was obtained by 5 m/s mean time due to inherited contracted features of muscles and the appearance of elastic energy before concentric movement. Plyometric training includes explosive exercise to activate the quick response and elastic properties of the major muscles. It was initially adopted by Soviet Olympians in the 1950s and then sporting worldwide. Sports using plyometric include basketball, squash, and volleyball as well as the various codes of football. The term “plyometric” was coined by Fred wilt after watching Soviet athletes prepare for their event in track and field. He began a collaboration with trainer Michael Yesses to promote plyometric.

Since its introductions in the early 1980s, two forms of uniform plyometric have evolved. In the original version, created by Russian scientist Yuri Verkhoshanasky; it was defined as the shock method. In this, the athlete's world drops down from a height and experiences a "shocked" upon landing. This in turn world brings about a forced eccentric contraction which was then immediately switched to a concentric contraction as the athletes jumped upward. The landing and takeoff were executed in an extremely short range of 0.1-0.2 seconds. Explosive plyometric describes the approach created by Verkhoshansky. He experimented with many different exercises, but the depth jump appeared to be the best for duplicating the forces in the landing and takeoff. The second version of plyometric, seen to a greater extend in the United States, involves any form of jump regardless of execution time. The term plyometric become popular with the publication of the book on the subjects.

The term "plyometric" refers to specific exercise which encompasses a rapid stretching of muscle that is undergoing eccentric stress followed by a concentric, rapid contraction of that muscle to develop a forceful movement over a short period **(the Chu, 1983)**. For an exercise to be truly plyometric, it must be a movement preceded by an eccentric contraction. This result not only stimulating the proprioceptors sensitive to rapid stretch, but also in loading the serial elastic components (the tendon and cross bridges between muscle fibers) with a tendon force from which they can rebound**(chu,1998).** As an athlete's lands on the ground during a plyometric training a plyometric exercise, a stretch occurs in the involved muscle fibers. Proprioceptors within the muscles tissue immediately sense this stretch and send a message to the spinal cord through an afferent or sensory neuron. The spinal sends an immediate massage back to the muscle fiber via an efferent or motor neuron, telling it to contract to keep it from overstretching. This is known as the "stretch reflect" and it is one of the body's built-in protection mechanisms for the prevention of injuries to muscles fibers. Plyometric exercise can be used to train body the to emit this sensor signal in a shorter period which causes the effected muscles to react more quickly (Freeman and Freeman, 1984). Hochmuth (1974) also stated that "a body movement, requiring an extremely high-end velocity can best be achieved by starting it with a movement in the opposite direction. The breaking of the opposite movements creates positive acceleration power for the original movements." Most human movement activities involve a counter-movement during which the muscles involved are first stretched and then shortened to accelerate the limb. This action of the muscles is called a stretched shorting cycle (SSC) **(komi, 1986)** and involves some

interesting neural and mechanical processes. A great deal of research has been directed towards the study of the stretching **cycle (Boaco and Komi, 1979; et.al; 1982;**

The speed of muscular exertion is limited by neuromuscular co-ordination. This means that the body will move most effectively and efficiently within a range of speed that the nervous system has been programmed to allow. Plyometric training improves both neuromuscular efficiency and a range of speeds set by the central nervous system. The optimum reactive performance of any activity depends on the speeds at which muscular forces can be generated **(Esteem, et.al. 1990).**

STATEMENT OF THE PROBLEM

The purpose of the study was to investigate the relative "**Effect of uniform plyometric training programme on motor fitness parameters of teen-age athletes."**

OBJECTIVES OF THE STUDY

- To understand the effect of 3 months of uniform plyometric training on speed, agility, power, shoulder strength, the reaction time of Sprinters.
- To understand the effect of 3 months of uniform plyometric training on speed, agility, power, shoulder strength, the reaction time of Jumpers.
- To understand the effect of 3 months uniform Plyometric training on speed, agility, power, shoulder strength, the reaction time of Throwers.

DELIMITATION

- Population: 100 meters and 200 meters sprinters, long jumpers, triple jumpers and shot-putters, discus throwers of state-level male or female teen-age athletes of West Bengal from each group was considered as subjects.
- Sampling: Purposive sampling technique was considered for the purpose of this study.

- Group: 10 sprinters, 10 jumpers, 10 throwers, and 10 control group (3 sprinters, 3 jumpers, and 4 throwers) was considered as subjects for this study. In the meantime, the first three groups are experimental.
- Age: 15-19 years.
- Area: The study was restricted to 40 students of school games in barasat athletic coaching center club, Barasat, (N) 24 Parganas, West Bengal.
- Period: The training period was delimited to 12 weeks.

LIMITATION

- Climatic conditions were considered as limiting factors.
- Genetic and economic factors were considered as limiting factors.
- Psychological factors, food habits, resting period, lifestyle, etc. could not be controlled.
- Since the subjects were from the coaching center their past experiences in the field of sports and games were not taken into consideration.
- The growth and developments of the subjects if any during the period of experimentation and its possible influence on the variables could not be controlled. However, the controlled group was employed to nullity the effect of maturation.

HYPOTHESIS

On the basis of knowledge reflected by the available literature, research findings, experts' opinions, and scholars won understanding of the problem it is hypothesized that there would be no significant differences in speed, agility, power, shoulder strength, and reaction time for the effect of 3 months uniform plyometric training applied on teen-age sprinter, jumper and throwers.

SIGNIFICANCE OF THE STUDY

- The study may make a significant contribution to enriching the existing knowledge of 3 months of plyometric training.
- The study may throw some light on the effects of plyometric training on motor fitness parameters.
- The study may be useful in preparing some training programmed for young men/women or even athletes for the development of motor fitness parameters.
- The study may be of some worth for remedial, curative, and rehabilitative programmed for patients suffering from various motor fitness problems.

REVIEW OF RELATED LITERATURE

Aashis et. al., (2015) investigated the effect of plyometric training programme on the agility performance among male basketball players. To achieves the purpose of this study a group of thirty(30) male basketball players age ranged between 18-24 years, were selected from two basketball academics in japer region. The agility was measured by the help of T-test and Barrows Zigzag test. The paired t-test was use to assess the mean of pre & post-test differences. A level of $p \leq 0.05$ was considered significant.

Abbas (2009) conducted a study that was to evaluate the "Effect of plyometric training with three modes on leg muscle strength". 40 subjects were from untrained male University students within the age range from 18 to 27 years. The subjects were randomly selected and divided into three experimental and one control group. The data was collected during the twelve weeks of the training period and analyzed using descriptive measures, ANCOVA, and Scheffe post hoc analysis. It was found that plyometric exercises with depth rebound jumping improved the leg muscle strength.

Amrinder (2013) conducted a study that was to compare the "Effects of four weeks plyometric training on two different surfaces, sand and grass on muscle soreness and selected sport-specific performance variable in national-level hockey players". Subjects were randomly divided into two groups namely the grass training group (N=20) and the sand training group (N=20). The variables tested were strength, endurance, balance, agility, and

muscle soreness. After 4 weeks of training with three sessions per week similar improvements in strength,, endurance, balance, and agility were found in both the surface but induced significantly less muscle soreness.

Ashok, et al. (2012) conducted a study that was to investigate "The effect of skill training and its combination of plyometric with skill training on jumping ability, anaerobic capacity and skill performance among volleyball players". For this sixty male volleyball players from various colleges in Coimbatore District, Tamilnadu was selected as subject and divided into plyometric and skill training (20), skill training (20), and control (20). Jumping ability, anaerobic capacity, and skill performance were tested during 12 weeks of the training programme. The result reveals that skill training with plyometric significantly improves jumping ability anaerobic capacity and skill performance among volleyball players.

Brown et al., (1986) conducted a study that was to find out the effects of plyometric training on vertical jump in male high school basketball players (n=26). Players were randomly assigned either to a training group or a control group. The training group performed 3 sets of depth jumps 3 days/week for 12 weeks. The control group performed only the regular basketball training. The plyometric group improved in the vertical jump with arm assistance significantly more than the control group. The two groups were not significantly different in the vertical jump without arm assistance. In the plyometric group, 57 percent of the vertical jump gain was due to jumping skill improvement, and 43 percent was due to strength gain. There force plyometric training appears to enhance the coordination of the arms with strength development of the legs and provides a convenient in-session training method.

Campillo, et al. (2013) Conducted a study that was to examine "Plyometric training on different volume and training surfaces on neuromuscular performance". To achieve this purpose twenty-nine subjects were divided into 4 groups namely, the moderate volume group (n=9), the moderate volume hard surface group (n=8), the high volume group (n=7), and the control group (n=5). Maximum strength, squat jump, countermovement jumps, 20 m sprint, agility, body weight, and height were measured before and after 7 weeks. The results reveal that high training volume significantly increased the explosive performance. Further, plyometric training on a hard surface and moderate training volume significantly improved the explosive performance, maximal strength, and speed.

Chaouachi, et al. (2013) Conducted a study was to compare the "Effectiveness of plyometric and its combination with balance training on balance and power parameter in children". The subject was divided into three groups namely, plyometric training group (n=14), combined balance and plyometric training group (n=14), and control group (n=12). Strength, power, speed, static and dynamic balance, and agility were tested during eight weeks of training. The combined group showed better improvement in leg stiffness, speed, agility than the other groups.

De Villarreal et al. (2009) conducted a study that was to examine a meta-analysis of 56 studies with a total of 225 effect sizes (ESs) to analyze the role of various factors on the effects of plyometric on VJH performance. The inclusion criteria for the analysis were a) studies employing true experimental designs and valid and reliable measurements and c) studies including enough data to calculate ESs. Subjects with more experience in sport obtained greater enhancements in VJH performance ($p< 0.01$). Subjects in either good or bad physical condition benefit equally from plyometric work ($p<0.05$), although men tend to obtain better power results than women after plyometric training ($p<0.05$). with relation to the variables of performance, training volumes of more than 10 weeks and more than 20 sessions, using high–intensity programs (with more than 50 jumps per session) were the strategies that seemed to maximize the probability of obtaining significantly. Greater improvements in performance ($p<0.05$). To optimize jumping enhancement, the combination of different types of plyometric (squat jump+ countermovement jump + drop jump) is recommended rather than using only 1 form ($p<0.05$). However, no extra benefits were found to have gained from doing plyometric with added weight. The responses identified in this analysis are essential and should be considered by strength conditioning professionals about the most appropriate dose-response trends for optimizing plyometric-induced gains.

METHODOLOGY

This chapter deals with the procedure followed in the selection of the subjects, selection of variables, selection of tests, instrument reliability of the data, pilot study, an organization to the subjects, training programmed, collection of data, test administration, experimental design, statistical procedure and justification for statistical techniques applied for analyzing the data.

Selection of the subjects

The purpose of the pre-test was to find out the effects of uniform plyometric training on the motor fitness of teen-age athletes.

For the study, 40 athletes were randomly selected as subjects. The age of the subjects ranged between 14 to 19 years state levels athletes. The selected subjects were divided into three experimental groups and one control group with ten subjects in (10) each group. The different experimental groups (sprinter, jumper, and throwers) were trained by uniform plyometric training protocol for the twelve weeks but the control group didn't receive plyometric training protocol.

All the subjects were informed about the nature of the study and their consent was obtained to co-operate till the end of the experiment and testing period. The experimental group and control group also trained-up in daily normal activity. Qualified coaches examined the subject's physical fitness for the study. They were free to withdraw their consent in case they felt any discomfort during the period of their participation, but there were no dropouts. All subjects were eligible for the study because everyone had participated in state-level school games competition.

Selection of variables

Success in many sports depends heavily upon the athlete's explosive leg power and muscular strength. In jumping, throwing, track and field events, and other activities, the athlete must be able to use strength as quickly and forcefully as possible. Power represents the amount of work a muscle can produce per unit of time. An increase in power gives the athlete the possibility of improved performance in sports in which the improvement of the speed-strength relationship is sought.

Given the nature of the sport, athletes and sports champions have various needs, priorities, and preferences in terms of physical fitness and mobility status. In other words, all sports courses hold individual requirements in strength, endurance, power, flexibility, and speed, or a combination of them; which vary from one sport to another. Muscle power is an effective parameter to success. In physical education, it refers to the maximal force that a muscle generates in the shortest possible time in order to confront the resistance, it is equal to muscular force or explosive power.

Plyometric training involves specific muscles in eccentric-concentric movement cycles. The frequency of eccentric (stretching) and concentric (shortening) actions provides higher power than simple concentric action. Elastic energy within the muscle can produce more force. Increased power generation plays an important role in improving sprint running times, which require high explosive power. **Cavagna et al. (1971)** evaluated the amount of force generated during sprint running, from start to end points (9.4 m/s), and found that the peak power out puts was obtained by 5 m/s mean time due to inherited contracted features of muscles and the appearance of elastic energy before concentric movement.

SELECTION OF VARIABLES

The selected parameters to be taken for this study are-

- Speed
- Agility
- Power
- Shoulder strength
- Reaction time

CRITERION MEASURE

- Speed to be measured by 50-meter sprint and the result was recorded to the nearest1/100th seconds.
- Agility to be measured by 4×10 meter shuttle run test and the results were recorded to the nearest1/100th seconds.
- Power to be measured by Standing Broad Jump and the results were recorded in meter.
- Shoulder strength was measured by pull up test in one minute and the number of legal pull up was considered as a result.
- Reaction time to be measured by Nelson-Choice-Response movement test results was recorded to the nearest1/100th seconds.

CRITERION MEASURES AND SELECTION OF TESTS

The present study was undertaken primarily to find out the effect of uniform plyometric training on motor fitness parameters of teen-age athletes. The following test was administered to measures the selected motor fitness parameters for athletes. The tests were administered to the subjects before and after the training programme.

ADMINISTRATION OF TEST

I) 50-meter sprint

II) 4x10 meter shuttle run

III) Pull up test

IV) Standing Broad jump

V) Nelson-Choice-Response movement test

TRAINING PROGRAMME

During training period the experimental groups underwent their respective uniform plyometric training programme in addition to their daily regular activities as per the schedule. Experimental group namely experimental group-I(Sprinter), experimental group-II(Jumper), and experimental group-III(Thrower0 underwent their respective experimental training on three alternative days per week for twelve weeks. The experimental training programmers were designed based on the recourses collected from books, periodicals, e-materials, and discussions with the experts. The duration of experimental training was planned for 60 minutes. The subjects reported for experimental training between 3.00 pm and 4.00 pm. All the subjects involved in this study were carefully monitored throughout the training programme and 90 percent attendance, were there for the participants.

GENERAL STRUCTURE OF TRAINING PROGRAMS

GROUPS WITH TRAINING PARTICULARS	TRAINING
Experimental Group-I(sprinter)	Regular activities & plyometric training
Experimental Group-II(jumper)	Regular activities & plyometric training
Experimental Group-III(thrower)	Regular activities & plyometric training
Control Group-IV	Regular activities
Training duration	Sixty minutes
Training session per week	Three days
The total length of training	Twelve weeks

COLLECTION OF DATA

The variables used in the present study were assessed from all the subjects before they have to treat with the respective treatments. It was assumed as pre-test. After completing of treatment they were tested again as it was in the pre-test on all variables and assumed as post-test.

STATISTICAL TECHNIQUES AND THEIR JUSTIFICATION

The following statistical techniques were adopted to treat the collected data n connection with the established hypothesis and objectives of this study.

To find out the differences between pre-test and different post-test of each group. Repeated measure ANOVA and ANCOVA were computed because the subjects were selected by simple random sampling, but the groups were not equated about the factors to be examined. Hence the differences between the means of the four groups in the pre-test had to be taken into account during the analysis of the post-test differences between the means. This was achieved by the application of analysis of co-variance, where the final means for differences in the initial means were tested significantly.

Whenever the post-test mean were found significant, the Tukey post-hoc test was employed to find out the mean differences. To test the obtained results on different parameters, level of significance 0.05 level was chosen and considered sufficient for the study.

RESULTS, CONCLUSIONS AND RECOMMENDATIONS

RESULT OF THE STUDY

From the analysis of data following results were obtained-

1. The present study clearly showed that the different post-test performances were significantly improved than pre-test performance by the treatment of uniform plyometric training. In this context, less time indicates betterment of the performance of speed (sprinter, jumper, and thrower). In different post-test, gradually decreased speed time means the performance of speed (sprinter, jumper, and thrower) enhanced. That's why it was clear that the uniform plyometric training is a very effective improvement in speed for the teen-age athletes (sprinter, jumper, and thrower) performance.
2. The present study showed significant differences in post-test-3 scores i.e. post test scores after twelve weeks of uniform plyometric treatment. All the groups showed significant improvement in sprint performance, which was greater than the control group. There was a significant difference between performances of all groups after the adjustment of Pre Test scores of four groups. That's why it was clear that the uniform plyometric training is very effective in the improvement of sprinting performance in speed of teen-age athletes.
3. The present study clearly showed that the different post-test performances were significantly improved than pre-test performance by the treatment of uniform plyometric training. In this context, distance increases indicate betterment of the performance of standing broad jump (sprinters, jumper, and throwers). In different post-test, gradually increased distance means the performance of standing broad jump (sprinters, jumper, and throwers) enhanced. That's why it is clear that plyometric training is very effective for the improvement of teen-age athletes' (sprinters, jumpers, and throwers) performance.

4. The present study demonstrated that Jumpers showed higher performance enhancement after the treatment. The mean performance of the control group was always lower. The present study showed significant differences in post-test-3 scores i.e. post test scores after twelve weeks of uniform plyometric treatment. All the groups showed significant improvement in sprint performance, which was greater than the control group. There was significant difference between performances of all groups after the adjustment of Pre Test scores of four groups. That's why was is clear that uniform plyometric training is very effective in the improvement of sprinting performance power of teen-age athletes.

5. The present study clearly showed that the different post-test performances were significantly improved than pre-test performance by the treatment of uniform plyometric training. In this context, less time indicates betterment of the performance of agility (sprinters, jumper, and throwers). In different post-test, gradually decreased speed time means the performance of agility (sprinters, jumper, and throwers) enhanced. That's why it is clear that the uniform plyometric training is a very effective improvement in agility for the teen-age athletes (sprinters, jumpers, and throwers) performance.

6. The present study showed significant differences in post-test-3 scores i.e. post test scores after twelve weeks of uniform plyometric treatment. All the groups showed significant improvement in agility performance, which was greater than the control group. There was significant difference between performances of all groups after the adjustment of pre-test scores of 4 groups. That's why it was clear that the uniform plyometric training is very effective in the improvement of sprinting performance of the teen-age athletes in agility.

7. The present study clearly showed that the different post-test performances were significantly improved than pre-test performance by the treatment of uniform plyometric training. In this context, the number of pull up increased indicates the betterment of the performance of shoulder strength (jumpers). In different post-test, gradually increased number of pull up means the performance of shoulder strength (jumpers) enhanced. That's why it was clear that plyometric training is very effective for the improvement in pull up of teen-age athletes (jumpers) performance. But in the

present study sprinters and throwers showed no improvement in performance after 4, 8, and 12 weeks of treatment so far as pull-ups activity was concerned.

8. The present study clearly showed that the different post-test performances were significantly improved than pre-test performance by the treatment of uniform plyometric training. In this context, less time indicates betterment of the performance of reaction time (sprinters, jumpers, and throwers). In different post-test, gradually decreased time means the performance of reaction time (sprinters, jumpers, and throwers) enhanced. That's why it was clear that the uniform plyometric training is a very effective improvement in reaction time for the teen-age athletes (sprinters, jumpers, and throwers) performance.
9. The present study showed significant differences in post-test-3 scores i.e. post test scores after twelve weeks of uniform plyometric treatment. All the groups showed significant improvement in reaction time performance, which was greater than the control group. There was significant difference between performances of all groups after the adjustment of pre-test scores of four groups. That's why it was clear that the uniform plyometric training is very effective in the improvement of sprinting performance in reaction time of teen-age athletes.

TESTING OF HYPOTHESIS

The formulated hypothesis is rejected because the result established that, the 3 months of uniform plyometric training produced significant improvement in speed, agility, power, shoulder strength, and reaction time for teen-age sprinters, jumpers, and throwers.

CONCLUSIONS OF THE STUDY

Within the limitation of the study and based on the result of the study the following conclusions may be drawn-

1. The twelve weeks of uniform plyometric training produces more effective improvement in motor fitness parameters for sprinters.

2. The twelve weeks of uniform plyometric training enhances the performance in motor fitness parameters for jumpers.
3. The twelve weeks of uniform plyometric training produces more effective changes in motor fitness parameters for throwers.
4. The performance of the speed is more effective, increased by uniform plyometric training. The speed of the jumper is most effectively improved as compared to sprinters and throwers.
5. The performance of the power highly improves by uniform plyometric training. The power of the thrower is most effectively improved as compared to sprinters and jumpers.
6. The agility of the thrower is most effectively improved as compared to sprinters and jumpers. The performance of the power highly improves by uniform plyometric training.
7. There is no effective improvement of shoulder strength in sprinters and throwers after three months of uniform plyometric training. The shoulder strength is improved for the jumpers as a result of uniform plyometric training.
8. The reaction time is improved by the uniform plyometric training programme. The reaction time of the sprinters is mostly affected by the uniform plyometric training programme.
9. It is concluded that the uniform plyometric training protocol adopted for the study is capable of improving motor fitness parameters for sprinters, jumpers, and throwers.
10. The uniform plyometric training better improves the motor fitness parameters like speed, agility, power, reaction time, and shoulder strength for throwers as compared to the sprinters and jumpers. Whereas, there are not much more differences in the shoulder strength improvement for the different groups.
11. The uniform plyometric training programme for twelve weeks may be the most appropriate protocol to produce more effective improvement in motor fitness parameters for teen-age athletes like sprinters, jumpers, and throwers.

RECOMMENDATIONS OF THE STUDY

Although the investigator has put in his best efforts on the present study, still the topic has a wide scope for further research. Thus, for future research and in the light of the results and conclusions of the study following recommendations is made:

1. It is assumed that twelve weeks of plyometric training may be sufficient to bring desirable changes in the fitness level of beginners. Hence further studies may be undertaken by extending the training period for the sportsperson.
2. The similar study may be conducted by using only female or only male athletes.
3. Based on the results of the study, the investigator suggests that there is a need to encourage youth and children to participate in plyometric-influenced sports to maintain good health and successful life.
4. Similar study may be conducted by Plyometric training which may be considered as a regular part of the training programme for an athlete of various sports and games.
5. It is recommended that coaches, trainers, and athletes interested in developing different types of motor fitness and skills should adopt these types of plyometric exercises in training, with this objective research may be organized.
6. A similar study may be conducted with a longer duration and larger sample to find out any better result.
7. Such study may be conducted among different age groups, players of different disciplines and extending the training period or modifying the same.
8. The results of the present study may be very much useful for physical educators and coaches for screening and selecting potential players at the national level and international level by knowing their attitude hence new research may be conducted for the above purposes.
9. It is also recommended that a football and hockey team at any level should know about plyometric training for enhancing their performance, so the research may be concluded for the major games also.

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