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Qualitive changes of the motor abilities and stylized movement structures in rhythmic gymnastics under influence of the kinesiology

Key words: **training, proprioception, man's rhythmic gymnastics**
Ključne riječi: **trening, propriocepcija, muška ritmička gimnastika**

Original scientific paper

Abstract
Aim of this research is to establish the effects of the three month long experimental program with the rhythmic gymnastics and proprioceptive exercises as a main operator. Research was performed in completely new sport event, man's rhythmic gymnastics, which in future will evolve and become recognized sport. Sample of the examinees (N=71) consisted of third year students of the Faculty of Sport and Physical Education in Sarajevo. Examinees were involved in a three month long rhythmic gymnastics training program along with additional proprioception training twice per week and each 30 minutes long. We applied 9 variables in order to asses the successfulness of the rhythmic gymnastics elements performance with three requisites, hoop, rope, ball and 19 variables for the assessment of the motor abilities: balance, coordination, flexibility, explosive strength, segment quickness and neuromuscular quickness. Analyzed qualitative changes were significant and main conclusion derived was that propriception training accelerated the formation of the global operational structures which resulted in higher achievements and more quality movement. Based on this it can be concluded that the programming of rhythmic gymnastics training could be enriched with the propriception area elements as it is not excluded that this area has abundance of the specific content which can be applied at different forms of adequate methodical operations.

Sažetak
Cilj istraživanja bio je da se utvrde efekti tromjesečnog ekperimentalnog programa u kojem su operatori bili trening ritmičke gimnastike i proprioceptivne vježbe. Istraživanje je provedeno u jednoj sasvim novoj sportskoj disciplini muškoj ritmičkoj gimnastici koja tek treba da doživi svoj razvoj i potvrdu. Uzorak ispitanika (N=71) činili su studenti treće godine Fakulteta sporta i tjelesnog odgoja u Sarajevu. Ispitanici su učestvovali u tromjesečnom programu treninga ritmičke gimnastike uz dopunski trening propriocepcije dva puta sedmično u trajanju od 30 minuta. Primjenjeno je 9 varijabli za procjenu uspješnosti izvođenja elemenata ritmičke gimnastike sa tri rekvizita (vijača, obruč i lopta) i 19 varijabli za procjenu motoričkih sposobnosti: ravnoteže, koordinacije, fleksibilnosti, eksplozivne snage, segmenterne brzine i brzine nervnomišićne reakcije. Analizirane kvalitativne promjene bile su značajne i zaključeno je kako je upravo proprioceptivni trening ubrzao formiranje globalnih upravljačkih struktura koje su rezultirale višim dometom i kvalitetnijim gibanjem. Na temelju svega može se reći kako bi se programiranje treninga u ritmičkoj gimnastici moglo znatnije obogatiti sadržajima s izrazitom zasičenošću iz prostora propriocepcije jer nije isključeno da se u tom arealu nalazi veliko bogatstvo koje je moguće aplicrati u razne oblike adekvatnih metodičkih operacionaliziranih postupaka.

Introduction

Grate number of the investigations in world, which were aimed at establishment of the anthropological status changes after transformational procedures, was published during last three decades. Examinations, although with different outcomes, defined certain human adaptation characteristics at different training procedures. Investigations that deals with the effects of the training procedures enables us to valorize them as less or more effective in reaching a certain goal (Malacko and Radjo, 2004). Movement control in humans is connected to the different levels of central nervous system activities. In order to reach an effective motor pattern control in that system (brain and spinal cord) it is necessary to have constant sensory information on performed movement. That sensory "feed back" on human movement and body location is called proprioception (*lat. proprius – own*).
Proprioceptors are sense receptors in deep tissues – joints, muscles, ligaments, inner ear (Grbavac, 1997; Harris and Dudley, 2000; Lephart and Fu, 2000). Kinesthetic receptors register changes in certain parts of body, creating so called movement awareness *(lat. kinezis, movement).* They are able to inform higher brain centers on interrelation of certain biomechanical levers, the angle between them an movement amplitude and all that without visual control. Besides this kinesthetic receptors influence muscle contraction, regulate expansion and muscle relaxation and play important role in creating a functional synergy of different muscle groups (agonist and antagonists) and in balance, and probably in other dimensions too (Starosta et al., 2002; Sebic-Zuhric, 2003; Simek, 2006).
To conclude, proprioception can be comprehended as complex action of neuron-muscular system regarding a transfer of the information from periphery receptors using afferent and efferent ways of nervous system enabling the body to maintain stability and orientation during the static and dynamic activities (Laskowski et al., 1997). That is activation or inhibition of the certain muscle groups according to the information on outside forces (Hoffman and Payne, 1995). Kinestension is improved using systematic training resulting in performance ability of more coordinated, precise, efficient and faster skills (Bompa, 2001) Large number of scientific research confirm the efficiency of the proprioception training in injury prevention (Gauffin et al., 1988; Sheth et al., 1997) in ankle and knee joint (Wedderkopp et al., 1999; Parkkari et al., 2001), rehabilitation (Bernier and Perrin, 1998; Irrgang et al., 1994; Vad et al., 2002), and only a smaller part of it in improvement of the certain number of motor abilities. The last group of the mentioned investigations is the least treated area which is the subject of ours investigation. Improvement of the motor abilities, noted in some of the investigations of the healthy and non-trained individuals in the area of balance (Hoff-

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man and Payne, 1995; Rozzi et al., 1999; Blackburn et al., 2000; Kollmitzer, 2000; Eils and Roesnbaum, 2001; Heitkamp et al., 2001; Ziegler et al., 2002) and in the area of the strength of the hamstring and quadriceps muscle (Heitkamp et al., 2001; Blackburn et al., 2002; Ziegler et al., 2002), and in investigations of the athletes (Tropp and Askling, 1988) represents one of the main problems of this paper. Even less investigated area are the effects of the proprioceptive training at the performance of the movement structures in different conventional sports. Investigation of Wolf-Cvitak, Grčić-Zubčević, Dolančić (2002) found that the learning certain movements, in poly - structural conventional sports such as rhythmic gymnastics cam be made faster by depending at kinesthetic awareness..

Aim of the paper

Transformational processes of the human anthropology status can be initiated by systematic or unsystematic influences. Extensity of the changes of the motor abilities is determined by genetic potential, biological growth and development, and it is possible to influence the improvement of the basic motor abilities potential by well structured training technologies (Malacko and Rađo, 2004). To establish the influence of the programmed kinesiology proprioceptive and rhythmic gymnastics training operators at the motor abilities and stylized movement structures would bi of significant interest for kinesiology an especially sport in practice. In that sense, this longitudinal study aim is to define qualitative (structural) changes that occurred between two time points in the area of the motor abilities and stylized movement structures of the rhythmic gymnastics.

Method

Sample of the examinees

Sample of the examinees consisted of 71 male, considered to be in a stabile phase of the development and growth , 20 - 25 years old, taken from the III year of study regular students of the Faculty of Sport and Physical Education in Sarajevo.

We applied 9 variables for the assessment of the stylized movement structures in order to asses the area of the apparatus exercises with hoop, rope and ball as a basic rhythmic realization: running steps forward and backward through the open rope (RVTR), side gallop trough open rope (RVGL), two legged rope hops in place with 180 degrees body rotation (RVSU), 180 degrees body rotation with rope drop and catch (ROVR), hoop roll-backs (ROKO), long-high jump with hoop drop and catch (ROSK), large ball rolls in balance (RLKO), horizontal eights with body waves (RLOS), 360 degrees body rotation with ball drop end catch (RLBA).

Variables for the assessment of the basic motor abilities were selected in order to cover the hypothetical areas of the explosive strength, segment velocity, coordination, balance, flexibility and neuromuscular reaction: balance at the computerized movement platform – Biodex Balance System (BABXS), Two Foot Lengthwise Balance – Eyes Closed (BAU2O), One Foot Lengthwise Balance – Eyes Open (BAU1O), Two Foot Cross Balance – Eyes Open (BAP2O), Ground Coordination (KONT), Stick Coordination (KKOP), Air Coordination (KOKZ), Plate Tapping (MTAP), One Foot Tapping (MTAN), Two Foot Tapping (MTAZ), Standing Broad Jump (MSDM), Vertical Jump (MSVM), Medicine Ball Put – Lying(MBML), Shoulder Flexibility with Stick (MFIS), Toe Touching (MFPR), Side Split (MSPA), Speed reaction at Sound (MRSS), Speed Reaction at Visual Signal (MRVV), Speed Reaction at Visual and Sound Signal Simultaneously (MRVS).

Experimental treatment lasted for three months and was shaped as training process aim at the development of the motor abilities and learning of stylized movement structures in rhythmic gymnastics. Rhythmic gymnastics training was realized according to the III year study curricula with additional complex proprioceptive training with the accent at the progression during 12 weeks 2 x a week (24 training units in total with 30 minutes duration). Individual exercises were realized in 30'' to 2' periods (Jukic et al., 2003) with equal rest period for the nervous path rest. Training was performed through system of complex exercises and tasks with the application of the different types of the proprioceptive training: at Biodex Balance System – maintaining a balance at the computerized movement platform, at balance boards with different constructions (type B and C boards), at balls of different size, weight and material (medicine, fitt-ball and rhythmic balls), at small trampoline, narrow constructions (boards, balance beams), unstable proprioceptive polygons, combined exercises with additional requisites manipulation (rope, hoop and ball). During the experimental period students had their usual activities according to their curricula.

Research data, according to the aim, upon the normalization were processed with relevant procedures for the quantitative changes analysis: Factorial analysis congruency method (factorial scores) and standard analyses of the structural changes (Bonacin 2004).

Results and Discussion

Structural (qualitative) changes are noticeable between at least two different measures with realized systematic transformational process in-between and in this case it was program of the proprioceptive training along with rhythmic gymnastics operators. As it can be noticed at Table 1., structural changes occurred an they were evident and statistically significant. Chi-square function does not leave any doubt in that possibilities, as well as the probability which is basically zero (0.0000). It can be concluded that the treatment initiated the restructuring of the movement control functions, which is interesting indicator having in mind that we had a sample that in sense of development is in stabile phase. This global change we can than explain to the all of the influences that occurred during the transformational process with this entities. It can not be excluded that actually proprioceptive training left its mark at the changes described, because for sure such a complex group of influences can induce the reconstruction of the functions in global sense, as with this sample.

Table 1.
Results of the LSDIF analysis of the structural changes

REAL TRACE OF SQUARE DIFF. MATRIX	=	25.9425
CHI-SQUARE (FUNCTION TRACE)	=	920.9583
DEG.OF FREEDOM	=	28
PROBABILITY	=	0.0000

Table 2. shows the results of the structural changes analysis under four different models. The first noticeable are that the structural changes in grate deal under each of the models were present at all of the variables used to asses the specific rhythmic movements. In general motor variables it is partially the case (balance, speed of the reaction), which points to certain function restructuring. It is presumable that for the preparation and realization of the rhythmic structures certain type of stimulus is necessary because theirs complexity can be seen in the interaction of several important factors such as music, rhythm, object, flight movements and similar. Than it is not odd that one part of the variability derived of specific movements is not approximately equivalent to the larger parts of the variability in movements defined as general motor tests. Harmonization of the control system process of movement learning, repeating, training and performance in rhythmic gymnastic and general motor abilities does not have to be specially manifested, especially if we take in to consideration that the sample is consisted of men. Characteristics of this sample is, in relation to the females, that for the realization of the activities they use dimensions of strength, explosive strength, repetitive strength, and in general their dominant dimension is the one that we proclaim as "energetic" regulation of movement. Informative regulation than, for sure, is a little less significant, which is partially understandable because sample represents already formed individuals, selected by many criterions (faculty of sport students). It is presumable that through their development and eventually sport activities they had a chance to adopt a grate deal of training influences in a way that the energetic movement dominants had a very important role in their activities and sports performance at any level. So it is clear that in a case of the transformational process such as this one, larger restructuring of the functions will occur in control segments of informational regulation, and by that it will be evident in a part of variables used for the rhythmic structure description. It is noticeable that changes occurred very similarly at all three of the requisites, and there are no special differences in a position of a ball, hoop and rope. This can be explained by the fact that although the ball is the object they had previously met with than the hoop and rope, these are the specific group of movements, so that previous knowledge had minimal transfer, at least in a sense of the structural changes.

Table 2.

Results of the structural changes analysis under 4 different models G = global value of change)
QDIFF1 (= large changes > 0.296, = significant changes > 0.200)
CRAMER (= large changes > 0.296, = significant changes > 0.200),
KRZANOWSKY (= large changes < 0.050, = significant changes < 0.100),
SCHONEMAN (= large changes < 0.296, = significant changes < 0.500),
CORRELATIONS (= large changes < 0.296, = significant changes < 0.500)

	QDIFF1	CRAMER	KRZANOWSKY	SCHONEMAN	CORRELATIONS
	Differences	Differences	Similarities	Similarities	Similarities
MBYS	0.27	0.32	0.07	0.00	0.42
MU2O	0.22	0.34	0.03	0.18	0.38
MP2O	0.19	0.28	-0.01	0.16	0.42
MU1O	0.17	0.30	0.01	0.00	0.46
MFIS	0.12	0.15	0.22	0.05	0.74
MFPR	0.05	0.06	0.13	0.04	0.91
MSPA	0.05	0.05	0.04	0.12	0.91
MTAP	0.12	0.11	-0.04	0.23	0.76
MTAN	0.16	0.23	0.02	1.08	0.51
MTAZ	0.19	0.22	-0.02	1.97	0.50
MONT	0.18	0.16	0.08	0.37	0.71
MOUZ	0.28	0.25	0.12	0.31	0.42
MKOP	0.20	0.17	0.00	0.24	0.66
MSDM	0.12	0.17	0.04	0.02	0.71
MSVM	0.17	0.11	-0.01	0.03	0.61
MBML	0.14	0.13	0.18	0.43	0.76
MRSS	0.29	0.27	0.15	0.01	0.35
MRVV	0.48	0.23	0.02	0.22	0.13
MRVS	0.34	0.21	0.07	0.02	0.26
RVTR	0.23	0.23	0.12	0.41	0.50
RVGL	0.24	0.32	0.01	0.03	0.36
RVSU	0.31	0.27	0.13	0.19	0.31
ROVR	0.24	0.33	0.10	0.01	0.26
ROKO	0.22	0.22	0.03	0.15	0.42
ROSK	0.25	0.26	-0.02	0.12	0.37
RLKO	0.28	0.30	0.05	0.01	0.33
RLOS	0.26	0.24	0.18	0.11	0.45
RLBA	0.21	0.30	0.14	0.20	0.37
G	0.27	0.22	1.00	0.38	0.50

One of the signs of the changes under the treatment influence are the coordination of the factor structures or the groups, although those changes are located in between structural and quantitative, considering that they share the part of the symbolic area of the factorial analysis performance manner. Table 3. and 4. show rotated groups of the treated sample, and table 5. show their congruencies. It can be seen that in a case of both measurements, 6 factors were derived, but the variable position that saturate those factors is very different. So at the first measurement clearly recognizable are: ***1) specific rhythmic movements, 2) frequency (speed), 3) flexibility, 4) reactivity, 5) explosiveness 6) coordination with balance.*** It can be concluded that the dimensions are clear but also relatively independent, except the frequency and coordination, as well as rhythmic activities, flexibility and explosiveness. Second measurement gave us following motor dimensions: ***1) specific rhythmic movements, 2) reactivity, 3) coordination and balance, 4) flexibility and explosiveness, 5) poorly defined factor of explosiveness and 6) frequency.*** It is more than clear that the specific movements' factor is better defined than at first measurement, which is a good sign of control segment homogenization, which is direct reflection of the learning process. The reaction at sound and visual sign are better defined, and especially the balance. The balance is maybe the most important characteristic of the second measurement, because it can be stated that the special proprioceptive training helped balance movement realization, or the establishment of the mechanisms that balance depends on. Factor correlations show now excellent position, because almost all of the rhythmic realization relations are significantly connected with other latent dimensions. This information is important, although it is hard to determine if the proprioceptive training caused it, as the examinees at the same time improved requisites handling. This can be sign that such training establishes better relations in movement control sphere, improves body position awareness so the movement efficiency should not be idea to abandon. Table 5. show congruency of factor groups in two measurements. It is visible that the correspondence is weak, and it is possible to recognize the similarity of specific movements and for a somewhat next three factors at second measurement. For sure explosiveness, frequency, coordination and balance changed theirs characteristics, which indicates structural changes.

Table 3.
Factor groups at first measurement and factor correlations (OBQ1,2,3,4,5,6 = orthoblique factor)

	OBQ1	OBQ2	OBQ3	OBQ4	OBQ5	OBQ6
1BYS	-0.26	-0.19	0.09	-0.38	-0.24	0.25
1U2O	0.10	-0.18	-0.12	-0.04	-0.26	0.73
1P2O	0.01	-0.03	-0.21	0.28	0.33	0.24
1U1O	0.31	-0.14	-0.32	0.26	0.20	0.62
1FIS	0.24	-0.36	-0.58	-0.26	0.19	0.04
1FPR	-0.11	0.07	0.79	-0.01	-0.05	-0.13
1SPA	-0.18	-0.11	-0.52	-0.04	-0.06	-0.20
1TAP	-0.33	0.62	0.02	-0.06	0.17	0.16
1TAN	0.18	0.81	0.02	-0.05	-0.03	-0.15
1TAZ	0.17	0.56	0.05	0.14	-0.01	0.18
1ONT	0.36	-0.32	-0.11	-0.02	-0.19	-0.57
1OUZ	-0.03	-0.06	-0.05	0.06	0.09	-0.60
1KOP	0.11	-0.17	-0.18	0.09	-0.09	-0.61
1SDM	-0.02	0.01	0.05	-0.15	0.80	-0.04
1SVM	0.01	0.02	0.02	0.07	0.86	-0.07
1BML	0.03	-0.16	0.60	-0.19	0.36	-0.08
1RSS	0.10	0.13	0.04	0.81	-0.23	-0.04
1RVV	-0.10	-0.23	0.10	0.70	0.02	-0.03
1RVS	0.08	-0.41	0.60	0.50	-0.03	0.14
1VTR	0.71	0.08	0.00	-0.06	0.03	-0.22
1VGL	0.45	0.42	-0.09	0.18	0.09	-0.07
1VSU	0.79	0.07	-0.19	0.16	0.08	-0.09
1OVR	0.14	0.56	0.16	-0.22	-0.19	0.01
1OKO	0.52	-0.13	0.35	-0.22	-0.06	0.07
1OSK	0.43	-0.31	0.29	-0.16	0.27	0.17
1LKO	0.54	-0.21	0.17	-0.34	-0.28	0.04
1LOS	0.67	0.13	-0.04	0.00	-0.06	0.20
1LBA	0.69	0.04	0.09	0.03	0.02	0.03
	OBQ1	OBQ2	OBQ3	OBQ4	OBQ5	OBQ6
OBQ1	1.00	0.11	0.25	-0.21	0.33	0.07
OBQ2		1.00	0.14	-0.17	0.18	0.40
OBQ3			1.00	-0.10	0.12	0.06
OBQ4				1.00	-0.06	-0.15
OBQ5					1.00	0.18
OBQ6						1.00

Table 4.
Factor groups at second measurement and factor correlations (OBQ1,2,3,4,5,6 = orthoblique factor)

	OBQ1	OBQ2	OBQ3	OBQ4	OBQ5	OBQ6
1BYS	**-0.05**	**0.27**	0.33	**-0.11**	**0.66**	**0.09**
1U2O	-0.25	0.16	-0.59	-0.25	-0.12	0.29
1P2O	-0.02	0.07	-0.69	-0.05	-0.02	0.02
1U1O	-0.02	0.04	-0.54	0.09	0.04	0.28
1FIS	**-0.08**	**0.14**	**0.04**	-0.44	**0.18**	**0.57**
1FPR	-0.20	0.24	-0.10	0.90	-0.09	-0.06
1SPA	0.01	0.07	0.13	-0.80	0.18	-0.12
1TAP	**0.20**	-0.44	-0.33	**-0.12**	**0.46**	**-0.01**
1TAN	0.05	-0.24	-0.31	-0.03	-0.14	0.65
1TAZ	**0.11**	**-0.08**	**0.01**	0.31	**0.06**	**0.53**
1ONT	0.08	-0.12	0.78	-0.12	-0.34	0.15
1OUZ	-0.24	0.09	0.67	-0.02	-0.05	0.38
1KOP	0.02	0.11	0.57	-0.09	0.06	-0.02
1SDM	**0.00**	**0.06**	**0.16**	**0.53**	0.32	0.38
1SVM	0.09	-0.01	-0.17	-0.03	0.58	0.03
1BML	**0.18**	**-0.10**	**0.14**	**0.56**	0.32	**-0.10**
1RSS	0.12	0.78	-0.18	0.05	-0.11	-0.19
1RVV	0.03	0.77	0.00	-0.12	0.22	0.00
1RVS	0.00	0.86	-0.01	0.05	-0.04	0.10
1VTR	0.77	0.08	0.02	0.03	-0.11	0.13
1VGL	0.73	0.13	0.02	-0.10	-0.25	0.26
1VSU	0.78	0.15	-0.11	-0.09	-0.25	0.10
1OVR	0.85	0.02	0.01	0.07	0.08	-0.10
1OKO	0.81	-0.05	0.16	0.18	-0.04	0.14
1OSK	0.78	0.03	0.13	0.06	0.19	0.06
1LKO	0.80	-0.12	-0.09	-0.02	0.03	-0.20
1LOS	0.87	0.00	-0.06	-0.05	0.01	-0.16
1LBA	0.87	-0.01	-0.06	-0.10	0.07	-0.01
	OBQ1	OBQ2	OBQ3	OBQ4	OBQ5	OBQ6
OBQ1	1.00	0.04	-0.28	0.27	0.20	0.28
OBQ2		1.00	0.04	-0.17	-0.06	-0.02
OBQ3			1.00	-0.08	-0.07	-0.24
OBQ4				1.00	0.18	0.08
OBQ5					1.00	0.18
OBQ6						1.00

Table 5.
Factor groups congruency at two measurements (OBQ1,2-1,2,3,4,5,6 = orthoblique factors of first and second measurement)

	OBQ2-1	OBQ2-2	OBQ2-3	OBQ2-4	OBQ2-5	OBQ2-6
OBQ1-1	0.84	0.07	0.00	-0.01	-0.29	0.25
OBQ1-2	0.20	-0.36	-0.29	0.14	-0.06	0.21
OBQ1-3	0.17	0.21	0.07	0.76	0.09	-0.21
OBQ1-4	-0.11	0.70	-0.23	-0.03	-0.23	-0.05
OBQ1-5	0.02	-0.10	-0.13	0.25	0.49	0.27
OBQ1-6	0.02	0.05	-0.76	0.00	0.19	0.05

Conclusion

This investigation presents one of the rare methodology investigations in sport kinesiology area performed at sample of the examinees that are kinesiology active. In this investigation we tried to determine the effects of the kinesiology treatment at the qualitative changes of motor abilities and stylized movement structures related to the conventional sport such as rhythmic gymnastics.
We programmed and realized transformational treatment with the aim to determine effects of the treatment at students 20 to 25 years old. Total sample consisted of 71 male examinees. We applied 28 variables in total in order to asses the entities condition. 19 of them were for the general motor variables covering sub areas of balance, flexibility, frequency, coordination, explosiveness, reactivity. 9 variables were used to asses the specific movements in rhythmic gymnastics covering the sub areas of rope, hoop and ball requisites exercises, as basic rhythmic realizations.
Results of the investigation show that clear structural changes occurred, which could be registered primarily through the variables for the assessment of the balance, reactivity and stylized movement structures in rhythmic gymnastics. This can be explained by the fact that the examinees learned new knowledge on rhythmic gymnastics (but also on other areas of study) in the period of treatment. Their improvement was defined by the process of adopting new engrams and integration of the information of the wider ranges, but for sure those from rhythmic gymnastics. This position limited them, because of the constant changes during a treatment, so the need for the adoption of new information without the possibility of the long-term stabilization and methodical proficiency at higher energetic level was constantly present.
The solution for this situation is clearly in long-term realization of the programmed rhythmic gymnastics activities as the means of multiple positive influences at the body, function structuring and development of some abilities. Factorial groups of the first and second measurement as well as their congruency point at this.
Results show that this concept of experimental treatment did not increase the exercises load, which could not reflect at the changes regarding the energetic sphere of the movement regulation, as well at the integration of the rhythmic gymnastics movement. The important conclusion of this investigation remains; proprioceptive training induced better adaptation and possibility of the fine regulation, and in that way the more quality level of the rhythmic gymnastics elements.

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