DANCE STEPS, DYNAMIC ELEMENTS WITH ROTATION AND THROW AND MASTERY ELEMENTS IN RHYTHMIC GYMNASTICS ROUTINES

Amanda Batista, Rui Garganta, Lurdes Ávila-Carvalho

Sports Faculty, Porto University, Porto, Portugal

Original article

Abstract

Analyze of individual elite routines allows to gain more knowledge about the performance of the RG structure. Therefore, the aim of this study is to know the difficulty elements diversity (dance steps, masteries and dynamic elements with rotation and throw) in individual routines of elite gymnasts who competed at the 2013 and 2014 Lisbon RG World Cup and to compare these characteristics across different ranking groups. 288 official difficulty forms of 4 routines were analyzed. The gymnasts' routines were clustered into three groups according to their ranking position. Non-parametric Kruskal-Wallis and Mann-Whitney tests were used. Pearson Correlation was used to analyze the association degree of the difficulty elements in the gymnasts' final score. The best gymnasts presented routines with some different characteristics, however, we verified a high similarity in the difficulties elements analyzed in the compositions that can compromise the originality and variety of this sport. We observed that the higher gymnasts' final score, have also higher departure difficulty score; lower number of combinations of base and criteria in masteries; higher number of non-fundamental and lower number of fundamental group elements in masteries. On the other hand, higher number of masteries and number of additional criteria of body rotations in dynamic elements with rotation and throw, lower the gymnasts' final score. However, we believe that the real differences in the ranking groups is mostly justified by evaluation of the judges of the difficulty elements presented in the official Difficulty forms and in the execution quality of the gymnasts.

Keywords: *difficulty elements, individual routines, elite gymnasts, rhythmic gymnastics.*

INTRODUCTION

Rhythmic Gymnastics (RG) is characterized by a high level of technical demand in the difficulty elements and apparatus techniques of rope, ball, hoop, clubs and ribbon, combined with the aesthetic and artistic aspects (Breitkreutz & Hökelmann, 2012; Hökelmann et al., 2012) RG competition routines are assessed according to the international RG Code of Points (RG-CoP). Every 4 years, at the end of the Olympic cycle, this code is improved and published by the RG Technical Committee of the International Gymnastics Federation (FIG) (Ávila-Carvalho et al., 2010). The main purpose is to provide a more objective evaluation of the competition routines and promote the sport development (Ávila-Carvalho et al.,

2012). The RG-CoP changes increase the difficulty and the demand of the competition routines requirements (Lisitskaya, 1995; Oliveira et al., 2004), according to the actual practice of the sport. However, the Code also determines the direction in which RG will evolve (Trifunov & Slobodanka, 2013).

The knowledge of the content of the high level gymnasts' competition routines including the details concerning the specificity of their components, can contribute to characterize the requirements allowing improvements in a gymnasts' preparation for competitions (Ferreirinha et al., 2011). Therefore, to identify trends in the performance structure, to understand how the RG-CoP is interpreted and to meet the compositional strategies used by reference coaches (Ávila-Carvalho et al., 2012) can be also useful information to coaches and gymnasts as feedback to determine the training models in order to improve performance (Fernandez-Villarino et al., 2013). However, the small number of studies about competition routines in RG (Agopyan, 2014) can be justified by the constant evolution of RG-CoP requirements. Thus, according to Lebre (1993), it becomes difficult to compare the results.

The content of the competition routines is represented by music, composition design and chose/combination of body and apparatus elements (Hökelmann et al., 2013), therefore, it is influenced by several qualitative and quantitative factors. The qualitative factors are highly dependent on subjective perceptions and in the other hand, the quantitative factors are more objective and, therefore, more suitable for performance analysis (Breitkreutz & Hökelmann, 2012; Hökelmann & Blaser, 2006; Hökelmann et al., 2012). The quantitative factors in individual routines in the 2013-2016 Olympic cycle include the difficulty elements: body difficulties; dance steps; masteries; dynamic elements with rotation and throw (DER) (FIG, 2012).

The aim of this study are to analyze the difficulty elements diversity and variety (dance steps, masteries and DER) of the individual routines of elite gymnasts who competed at the 2013 and 2014 Lisbon RG World Cup and to compare these characteristics across different ranking groups. Furthermore, to identify the difficulty elements included in the routines that contribute the most to the success in competition. The hypothesis of the study is that the finalists gymnasts (top 8 ranking gymnasts) have routines with higher scores and more complex elements (in quantity and difficulty) than the other lower-ranked gymnasts.

METHODS

A total of 288 individual routines from different countries performed in 2013 and 2014 Lisbon RG World Cups (Portugal) were analyzed according to 2013-2016 RG-CoP rules (FIG, 2012). This study was approved by the World Cup Organization.

Each participant performed 4 routines (hoop, ball, clubs and ribbon) and the analysis was carried out based on the Difficulty forms submitted prior to the competition by the coaches and not evaluated by the judges.

The gymnasts were clustered into three groups according to their ranking routine in each apparatus: 1st Group (Finalists) – 1st to 8th place in the ranking; 2nd Group – 9th to 22nd place in the ranking; 3rd Group – 23rd to 36th place in the ranking.

The analysis was conducted by two international RG judges. The high intraclass correlation coefficient values in the relative reliability analysis: intra-examiner (0.98) and inter-examiner (0.97), demonstrated high objectivity in the evaluations.

Table 1
Summary of fundamental and non-fundamental apparatus group elements of the RG-CoP (2013-2016).

Apparatus	Fundamental apparatus group elements	Non-Fundamental apparatus group elements
Hoop 	Passing through the Hoop with the whole or part of the body	Passing over the Hoop with the whole or part of the body
	Roll of the Hoop over minimum 2 body segments	Small throw and catch
	Roll of the Hoop on the floor	Throws or catches: Medium or Large throw
	Rotations of the Hoop around its axis: One free rotation between the fingers or on the part of the body / Series of rotations on the floor	Apparatus handling: Figure 8 with ample body movement; Large circles; Transmission of the apparatus around any part of the body or under the leg(s)
	Series of rotations around the hand / One free rotation around a part of the body	Unstable balance on the part of the body
Ball 	Roll of the Ball on the floor: Large (min. 1 meter) or series of small rolls	"Flip-over" movement of the Ball; Rotations of the hand(s) around the Ball; Series of assisted small roll; Roll of the body over the Ball on the floor; "Trust"/push of the Ball from different parts of the body
	Roll of the Ball over minimum 2 large body segments	Throws or catches: Medium or Large throw
	Catch of the Ball with one hand	Small throw and catch
	Series of small bounces or one high bounce; Visible rebound from a part of the body	Apparatus handling: Large circles; Transmission of the apparatus around any part of the body or under the leg(s)
	Figures eight of the ball with circle movements of the arms and ample movement of the trunk	Unstable balance on the part of the body
Clubs 	Mills: at least 4 small circles of the Clubs with time delay and by alternating crossed and uncrossed wrists/ hands each time	For 1 or 2 clubs: Free rotations on the part of the body or on the floor; Rolls on the part of the body or on the floor; Rebound from the body; "Sliding"; Tapping (min 1); "Trust"/push of the Club from different parts of the body
	Asymmetric movements of 2 Clubs	Small throw and catch of 1 Club
	Small throws and catches with rotation of 2 Clubs together simultaneously or alternating	Throws or catches: Medium or Large throw
		Throws or catches of 2 Clubs, simultaneous or asymmetric
		"Cascade" throws (double or triple)
		Apparatus handling: Figure 8 with ample body movement; Large circles; Transmission of the apparatus around any part of the body or under the leg(s)
		Unstable balance on the part of the body
Ribbon 	Spirals (4-5 waves); Spirals on the floor	"Boomerang" (in the air or on the floor)
	Snakes (4-5 waves); Snakes on the floor	Rotational movement of the stick around the hand; Roll of the stick on the part of the body; Rebound of the stick from the part of the body; Wrapping; Movement of the Ribbon around a part of the body created when the stick is held by different parts of the body
	Passing through or over the pattern of the Ribbon	Small throw and catch
	"Echappé"	Throws or catches: Medium or Large throw
		Apparatus handling: Figure 8 with ample body movement; Large circles; Transmission of the apparatus around any part of the body or under the leg(s)
		Unstable balance on the part of the body

Table 2
Summary Table of Additional Criteria of throw, body rotation and catch of apparatus in DER.

Additional criteria - throw of apparatus in DER
Outside of visual control during the throw
Without the help of the hands during the throw
Passing through the apparatus during throw
Throw with rotations around its diameter; on horizontal or vertical plane
Throw with oblique plane
Throw of 2 Clubs
Asymmetric throw of 2 Clubs
Throw under the leg/legs
Throw after bounces on the floor, after rolling on the floor, etc.
Additional criteria - body rotation in DER
Change of body rotation axis under the throw or during the catch of the apparatus
Change of level (two levels: flight/standing and floor)
Additional criteria - catch of apparatus in DER
Outside of visual control during the catch
Without the help of the hands during the catch
Passing through the apparatus during catch
Mixed catch of Clubs
Catch under the leg/legs
Direct catch in a roll
Direct re-throw / re-bound
Direct catch in rotation
Catch of the Ball with one hand

For statistical analyses of the data we used the Statistical Package for Social Sciences – version 20.0. The level of significance was set at $\alpha = 0.05$. Descriptive statistics were calculated using the mean, standard deviation (SD) and range values. The Kruskal-Wallis and Mann-Whitney non-parametric tests were used to compare the ranking groups. Pearson Correlation was performed to analyze the association degree of the difficulty elements in the gymnasts' final score.

RG-CoP rules (FIG, 2012):

- Fundamental (FGE) and non-fundamental apparatus group elements (NFGE): Table 1 presents the FGE and NFGE in hoop, ball, clubs and ribbon routines. These apparatus elements are performed in the dance steps, masteries and body difficulties, and they should be included in the official Difficulty forms.

- Masteries: The mastery consists of, at least, 1 base (1B) – FGE and/or NFGE, plus a minimum 2 criteria (2C). Or 2 bases (2B) plus minimum 1 criteria (1C).

- DER: Table 2 shows the additional criteria of throw, body rotation (during the fly of the apparatus) and catch of the apparatus performed in the DER.

RESULTS

Dance steps

The gymnasts presented similar number of dance steps and FGE in dance steps (Figure 1). No significant differences were found in the groups in all dance steps variables evaluated: number of dance steps (p=0.981); number of FGE per dance steps (p=0.728); number of dance steps by apparatus: hoop (p= 0.259); ball (p=0.685); clubs (p=0.357) and ribbon (p=0.694); number of FGE by apparatus: hoop (p= 0.899); ball (p=0.208); clubs (p=0.683) and ribbon (p=0.477) routines.

In Figure 1, we can see that all groups showed a higher number of dance steps in ribbon routines and higher number of FGE in dance steps in the clubs routines.

Masteries (M)

The routines presented 6 different combinations (Figure 2) of bases and criteria.

Although not necessary, many routines presented more criteria and/or bases than the required by the RG-CoP (FIG, 2012), because the element is valid if the gymnasts perform without execution faults at least the minimum number of base and criteria elements. The most routines presented the combination 1 base plus 2 criteria (3.62±2.11 masteries), probably because this is the easiest combination of bases and criteria required by the RG-CoP (FIG, 2012).

We verified that the higher the ranking position, the fewer types of combinations were observed: finalists (4); 2nd Group (5) and 3rd Group (6).

The gymnasts of 3rd Group showed a high range in the number of masteries (Table 3). Furthermore, this ranking routines presented a higher of masteries elements than the remaining groups, although no significant differences were found in the number of masteries in all groups analyzed (p=0.654). On the other hand, we observed a lower range in the number of masteries in finalists' routines.

The choice between using FGE or NFGE in masteries showed different values for the different groups (Table 3), although significant differences were found only in routines of 3rd Group (p=0.006). This group have a significant superior use of FGE in masteries. We observed that the higher the ranking position, higher the number of NFGE and lower the number of FGE in these elements in the routines.

Significant differences also were verified in finalists versus 3rd Group (p=0.013) in the number of masteries with NFGE.

The routines were analyzed by apparatus (Table 3) and we did not observe significant differences between groups in number of masteries: hoop (p= 0.369); ball (p=0.338); clubs (p=0.831) and ribbon (p=0.476). However, the ball and hoop routines in all groups analyzed had a higher number of masteries.

When we analyze the minimum and maximum values in Table 3, we observed that all apparatus routines of 3rd Group and finalists presented respectively, the higher and the lower range in the number of masteries.

The FGE in masteries are more used in hoop and ball routines, and NFGE are more used in clubs and ribbon routines in all groups analyzed. Significant differences were found in the number of masteries with FGE only in clubs routines (p=0.005), in finalists and 2nd Group versus 3rd Group, and in the number of masteries with NFGE in hoop routines (p=0.004) in finalists versus 3rd Group.

The masteries can be performed in body difficulty elements and we observed in Figure 3 that 39.1% of finalists, 40.2% of 2nd Group and 36.6% of 3rd Group routines presented at least one mastery performed during a body difficulty (jumps/leaps, balances or rotations). However, the 3rd Group showed higher number of masteries per routine, although without statistical significance.

When we compared the use of masteries performed during different body groups elements, no significant differences were found: rotations (p=0.833); balances (p=0.953) and jumps/leaps (p=1.000). However, the finalists have higher number of masteries performed during rotations and lower number performed during jumps/leaps than the other groups (Figure 3). Furthermore, balances are the body difficulty most performed during masteries in all groups analyzed.

Dynamic elements with Rotation and throw (DER)

According to the analysis of the official Difficulty forms, we observe that all routines had 3 DER elements. Furthermore, no significant differences were found in the ranking groups in all variables of DER. The 1st, 2nd and 3rd DER presented similar values in each of the criteria analyzed (Figure 4): number of rotations (p=0.337); total additional criteria (p=0.806); criteria of throw (p=0.862); criteria of body rotation (p=0.139) and criteria of catch (p=0.262).

The routines showed in average, for each DER element 3.3±0.4 rotations and 3.6±1.0 additional criteria: 0.9±0.6 criteria during the throw, 1.7±0.6 criteria of body rotation during the fly of apparatus and 1.0±0.7 criteria during catch.

The DER variables were analyzed per apparatus and no significant differences were found between the ranking groups in all apparatus (Table 4). However, we can highlight some results observed. The ribbon routines have the higher number of rotations and additional criteria of body rotation in all groups analyzed, however, these routines have a low number of additional criteria performed mainly during throw and catch of the apparatus.

The additional criteria are more used in hoop and clubs routines than in ball and ribbon routines. Among these additional criteria, we verified higher number of body rotations criteria during the fly of the apparatus in all apparatus and groups, except in finalists hoop routines.

The hoop routines showed a high and similar number of the three additional criteria performed in the DER (during the throw, fly and catch of the apparatus). In ball routines, we observed a low number of additional criteria performed only during the throw of the apparatus. In these routines, the DER have a higher number of criteria during the fly and catch of the apparatus. In the clubs routines, we can see a low number of additional criteria performed during apparatus catch only. Therefore, the additional criteria of throw are more used in hoop and clubs routines, and the criteria of catch of apparatus in hoop and ball routines.

Pearson Correlation

Through of Pearson Correlation (Table 5) were found the significant correlations between variables of study. The positive correlations show that these variables favor the final score, and the negative correlations mean that the increase in the number of these variables reflects negatively on the respective score.

Increases in the number of additional criteria of body rotations in imply a decrease in the gymnasts' final score. Routines with higher number of masteries with NFGE, departure difficulty score and difficulty score in the competition presented higher final scores.

Table 3

Number of masteries elements with fundamental and non-fundamental group elements in Rhythmic Gymnastics routines clustered according to their ranking position.

Apparatus	Ranking groups	Total Number M			Number M with FGE (x±sd)	Number M with NFGE (x±sd)
		Min	Max	x±sd		
General (all apparatus)	Finalists (n=64)	2	8	4.31±1.56	2.11*±1.93	2.52*±1.14
	2nd Group (n=112)	1	10	4.14±1.95	2.22±2.09	2.30±1.24
	3rd Group (n=112)	0	13	4.57±2.71	2.78*±2.33	2.02*±1.22
Hoop	Finalists (n=16)	3	7	4.56±0.96	2.81±1.64	2.56*±1.03
	2nd Group (n=28)	2	10	5.04±1.77	3.54±1.93	2.11±0.92
	3rd Group (n=28)	1	10	4.54±2.32	3.46±2.20	1.46*±1.04
Ball	Finalists (n=16)	4	8	5.88±1.26	3.94±1.73	2.19±1.33
	2nd Group (n=28)	2	10	5.21±2.10	3.50±1.93	1.96±1.23
	3rd Group (n=28)	1	13	6.32±3.38	4.14±2.55	2.32±1.39
Clubs	Finalists (n=16)	2	6	3.63±1.15	0.88*±0.96	2.88±1.15
	2nd Group (n=28)	1	6	3.54±1.32	0.71*±0.94	2.93±1.25
	3rd Group (n=28)	0	10	3.93±2.05	1,71*±1.49	2.25±1.18
Ribbon	Finalists (n=16)	2	6	3.19±1.38	0.81±1.28	2.44±1.03
	2nd Group (n=28)	1	6	2.79±1.42	1.14±1.60	2.21±1.37
	3rd Group (n=28)	1	9	3.50±2.11	1.79±2.04	2.04±1.10

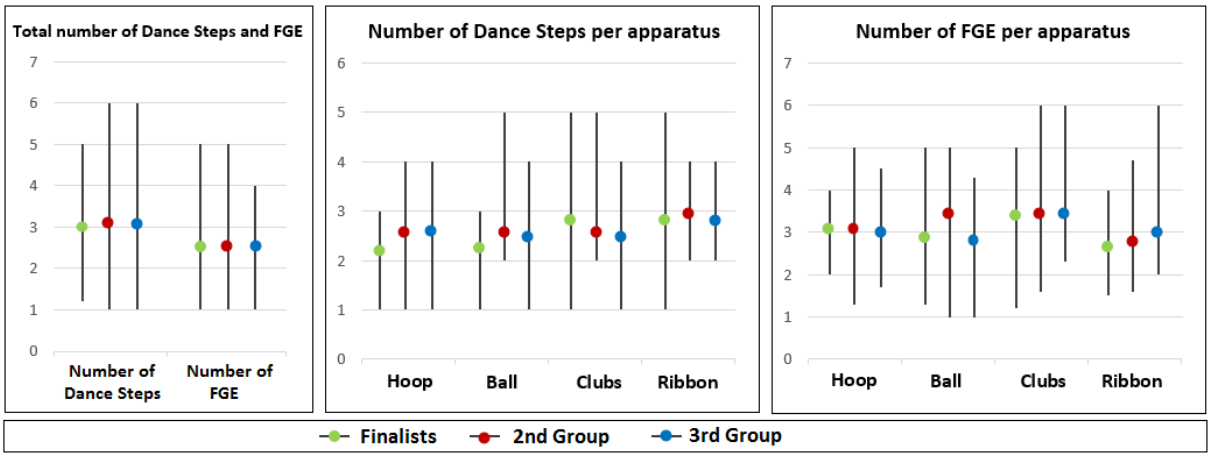

Figure 1. Dance steps data presented in the Rhythmic Gymnastics routines clustered according to their ranking position.

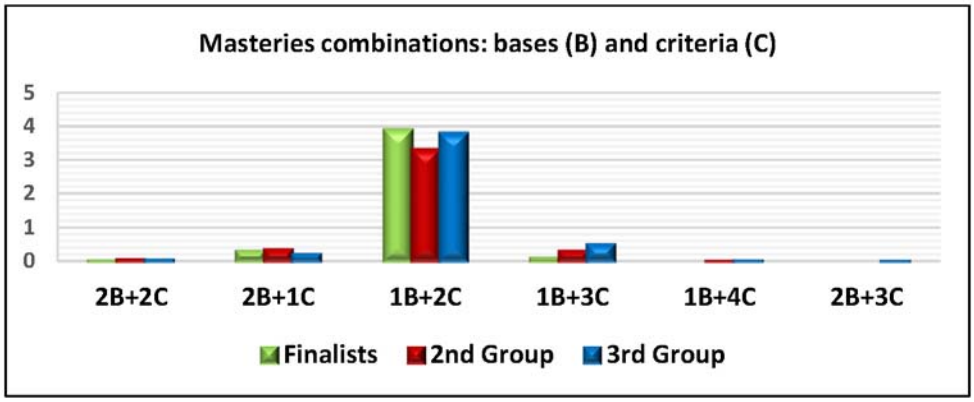

Figure 2. Combinations of bases and criteria in masteries in Rhythmic Gymnastics routines clustered according to their ranking position.

Table 4

Number of rotations and additional criteria performed in the DER per apparatus in the Rhythmic Gymnastics routines clustered according to their ranking position.

Apparatus	Ranking groups	Nº Rotations (x±sd)	Total nº add criteria (x±sd)	Nº add criteria Throw (x±sd)	Nº add criteria BD (x±sd)	Nº add criteria Catch (x±sd)
Hoop	Finalists (n=16)	3.12±0.49	4.25±1.05	1.02±0.55	1.38±0.74	1.85±0.49
	2nd Group (n=28)	3.24±0.39	4.42±0.84	1.27±0.1	1.66±0.61	1.49±0.65
	3rd Group (n=28)	3.10±0.43	4.25±0.73	1.04±0.50	1.67±0.57	1.55±0.60
Ball	Finalists (n=16)	3.04±0.34	3.19±0.70	0.33±0.32	1.54±0.74	1.31±0.65
	2nd Group (n=28)	3.16±0.33	2.91±0.61	0.29±0.31	1.51±0.52	1.11±0.51
	3rd Group (n=28)	3.07±0.52	3.29±0.81	0.37±0.29	1.74±0.76	1,18±0.58
Clubs	Finalists (n=16)	3.19±0.32	4.21±0.47	1.67±0.52	1.73±0.56	0.81±0.50
	2nd Group (n=28)	3.35±0.39	3.85±0.93	1.33±0.59	1.81±0.64	0.70±0.58
	3rd Group (n=28)	3.27±0.37	3.92±0.90	1.30±0.51	1.89±0.55	0.73±0.51
Ribbon	Finalists (n=16)	3.69±0.31	3.02±0.71	0.73±0.39	1.81±0.61	0.48±0.60
	2nd Group (n=28)	3.54±0.38	3.19±0.66	0.73±0.34	2.02±0.51	0.44±0.43
	3rd Group (n=28)	3.39±0.54	3.00±0.93	0.75±0.47	1.92±0.66	0.33±0.41

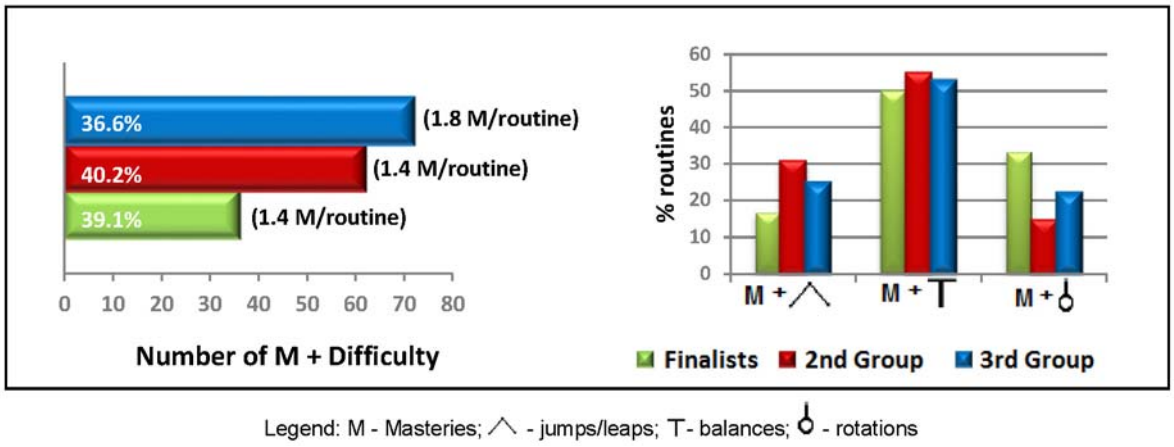

Figure 3. Masteries performed during a body difficulty elements in the Rhythmic Gymnastics routines clustered according to their ranking position.

Table 5

Pearson correlations – dependent and independents variables.

Dependent Variable	Independent Variables	Proof value	Pearson Correlation
Final Score in the competition	Nº Masteries with NFGE	p=0.002*	0.184
	Nº add criteria of body rotation (DER)	p=0.002*	-0.190
	Departure difficulty score	p≤0.001*	0.540
	Difficulty Score in competition	p≤0.001*	0.962

Legend: NFGE – non-fundamental groups apparatus elements; DER – dynamic elements with rotation and throw; * p ≤0.05: Significant differences

DISCUSSION

At every 4 years, at the end of the Olympic cycle, the RG-CoP changes and as a consequence of the constant and quick evolution of this sport, a permanent upgrade of studies about the composition of competition routines in RG are essential to know the direction in which RG is evolving (Bucar et al., 2013; Caburrasi & Santana, 2003; Čuk et al., 2012; Hökelmann et al., 2012; Massidda & Calò, 2012; Pelin, 2013).

Dance steps

The groups analyzed presented similar characteristics for the dance steps: similar number of dance steps and FGE performed. Therefore, these results showed that the main characteristics of the dance steps presented in the competition routines do not differ the gymnasts according to the ranking position, but the number of validated dance steps by the judges can differentiate them. However, Leandro et al. (2015) verified significant differences in agreement and disagreement on the dance steps evaluation between judges, demonstrating a high variability in the evaluation, probably due to lack of precision in the type of evaluation proposed by the RG-CoP. The authors explain that the dance steps have as criteria to be validate, the duration of at least 8 seconds, evaluated without a stopwatch or other device, but through the sensibility of the judge, and can be serious influenced by the music rhythm.

Leandro et al. (2015) recommend that the RG-CoP should include more precise definitions of the technical requirements. Simões (2000) explains that precise criteria allow a correct judgment of performance, due to the possibility of be understood equally by the various evaluators.

We observed that all groups presented a higher number of dance steps in ribbon routines, probably because of the deformable characteristics of the apparatus and the dance steps can bring greater beauty to the compositions. And also, perhaps, due to the length of the ribbon, the gymnasts have to maintain themselves in movement during the all routine duration to avoid the end of ribbon to touch the floor and consequent penalization (FIG, 2012). Therefore, they could choose the dance steps as a way to improve the continuous movement of this apparatus. The clubs routines had the higher number of FGE in each dance step in all groups analyzed, probably because the FGE in these apparatus are technical elements performed with a fast execution. So the gymnast can perform a higher number of apparatus movements in dance steps, showing apparatus mastery. The inclusion of complex abilities in the routines is essential to have a high score in the competition (Massidda & Calò, 2012).

Masteries

A similar number of masteries were found in all groups. As in dance steps, these results suggest that the number of the masteries presented in the gymnasts' official Difficulty forms do not differentiate the gymnasts according to the ranking position. However, we observed that the 3rd group presented a higher number of masteries than the remaining groups and this ranking position also showed a high range in number of masteries. In the finalists' routines we verified a lower number of masteries. We believe that these results can be motivated for two reasons. The best gymnasts normally present better physical and artistic capacities for the sport, which allows them to perform more and higher level elements with complex execution (Bobo & Sierra, 2006), while the less able gymnasts can resort to the masteries elements that depends especially on coordination, to increase the difficulty value of their routines. Furthermore, the higher number of masteries can be justified by lack of precision of the rules in RG-CoP (FIG, 2012) for these elements: the mastery must be unique and extraordinary because they are not performed on a regular basis as standard apparatus movements in RG. The masteries are complex apparatus handling and probably, several proposed elements in the official Difficulty forms were not considered by the judges as masteries. So we believe that the number of valid masteries elements executed without faults can also differentiate the gymnasts. However, according to Leandro et al. (2015) the masteries evaluation has a high disagreement between judges (62.5%). For the authors, the definition of

"extraordinary apparatus elements" presented in RG-CoP is vague to allow an accurate evaluate and could be also influenced by the international experience of the judges.

Therefore, the preference for the use of masteries can be part of justification of low results in 3rd group. The routines (ball, clubs and ribbon) of this group had more number of masteries. Probably, these gymnasts present a high departure difficulty score with elements that, in reality, they can not to perform correctly. There is an overvaluation of departure score and there is not a direct relationship to real performance capabilities of the gymnast (Leandro et al., 2016a).

We observed that in all groups analyzed there is a higher number of masteries in ball and hoop routines. We can also speculate that in ribbon and clubs routines the gymnasts invest more in dance steps than in masteries due the more execution difficulty in these apparatus and, probably, the opposite happens in ball and hoop routines.

The mastery consists of, at least, 1 base (1B) – FGE and/or NFGE, plus a minimum 2 criteria (2C). Or 2 bases (2B) plus minimum 1 criteria (1C). Although we observed 6 different combinations of bases and criteria, the most routines presented the combination 1 base plus 2 criteria, probably because this is the easiest combination of bases and criteria required by the RG-CoP.

Through the analysis we also found that the higher the ranking position, higher the number of NFGE and lower the number of FGE used in masteries. Therefore, the finalists showed more NFGE and less FGE in masteries than the other groups analyzed. The NFGE more used in masteries were apparatus handling, throws and catches in all apparatus. The routines of the lower ranking position had a higher number of masteries with FGE than finalists in all apparatus routines.

The masteries are spectacular elements (FIG, 2012) and when performed during body difficulty they become more complex to execute without faults. The results found showed that the lower the ranking position, higher the number of masteries in body difficulty elements per routine. Considering only the data of competitive routines with masteries in body difficulty elements, we observed 1.4 masteries in body difficulty elements per finalist and 2nd group routine, while a higher number of masteries in body difficulty (1.8) was verified per 3rd group routine. These data also can probably be one of the justifications for the ranking position.

According to Leandro et al. (2016a), rotations, masteries and DER have a higher contribution to the difference between departure and final difficulty score, due the more possibilities of technical faults which cancel the value of the difficulty, mainly the weaker gymnasts. These complex difficulty elements demand a lot of training hours, a singular coordination and high apparatus technical domain (Vitrichenko et al., 2011). To obtain top scores, the gymnasts should present routines with a high difficulty level combined with good performance quality (Agopyan, 2014). The inferior execution quality of middle and lower ranked gymnasts suggest that the coaches do not have a real perception of the performance capacity of their gymnasts in these types of difficulty elements (Leandro et al., 2016a).

Dynamic elements with Rotation and throw (DER)

DER are complex elements with body rotations during the fly of the apparatus. All groups analyzed presented the maximum number of DER in routines with similar number of criteria. These results suggest that the characteristics of DER presented in the gymnasts' official Difficulty forms also do not discriminate the ranking position. However, the number of valid DER or valid criteria can cause a distinction between the gymnasts. Leandro et al. (2016a) verified a high difference in

the departure and final difficulty score in DER elements in different ranking groups analyzed, although this difference increases as the gymnasts go lower in the ranking.

Through the analysis, we observed that for all groups, the lower the weight of apparatus, higher the body rotations number in DER performed in the routines. The weight of apparatus according to the Apparatus Norm (FIG, 2016) is the following: ribbon (35g minimum without the cane); clubs (150g minimum each); hoop (300g minimum) and ball (400g minimum). In the additional criteria performed during the throw of the apparatus, the groups analyzed presented lower results in ball and ribbon routines, and higher results in clubs and hoop routines; these differences are probably justified by the higher number of specific additional criteria in clubs and hoop routines presented in the RG-CoP (FIG, 2012). There are nine different types of additional criteria of throw (Table 3) in DER, however, 77.8% of these criteria can be used in clubs and hoop routines, while 44.3% in ball and ribbon routines. Furthermore, in the additional criteria performed during the catch of the apparatus, we observed that the gymnasts presented higher results in hoop and ball routines, and lower results in clubs and ribbon routines. Equally, we believe that the higher number of specific additional criteria in hoop and ball routines presented in the RG-CoP (FIG, 2012) explains this difference. There are nine different types of additional criteria of catch (Table 3) in DER, however, 77.8% of these criteria can be used in hoop and ball routines, while 66.8% in clubs and ribbon routines.

Similarly to the study by Leandro et al. (2016b), the most used criteria in DER were: "change of level", "change of body rotation axis", "throw/catch outside of visual control" and "throw/catch without the help of the hands".

Pearson Correlation

The small number of significant correlations among the analyzed variables is justified probably because the gymnasts have similar characteristics in all difficulty elements presented in the routines. However, we highlight the positive correlation between the masteries with NFGE and the final scores. The apparatus elements (NFGE) more used were the throw and catch of the apparatus.

CONCLUSION

The groups analyzed (finalists, 2nd and 3rd group) presented similar number of difficulty elements (dance steps, masteries and DER) in the official Difficulty forms in all apparatus. Furthermore, the difficulty level also was similar in the dance steps and DER. The similarity observed in these difficulty elements studied in the composition of routines in different apparatus in RG can compromise the originality and variety of this sport. As we only have access to the official Difficulty forms delivered by the coaches and not evaluated by the judges, we believe that the real differences in the groups reside mostly in the validation or invalidation by the judges of the difficulty elements presented in the official Difficulty forms and in the execution quality of the gymnasts in competition.

The best gymnasts (finalists) and the remaining groups showed routines with some different characteristics although without statistical significance, especially in the masteries elements. We observed that the higher of the ranking position, lower the number of combinations of base and criteria in the masteries, higher the number of NFGE and lower the number of FGE in the masteries. The routines with worse results in the competition presented high data range and higher number of masteries. Therefore, it seems that the coaches of the best gymnasts are more realistic in intention to accomplish the requirement and complexity of the

elements inscribed on the Difficulty official forms.

ACKNOWLEDGEMENTS

The authors would like to thank the Gymnastics Federation of Portugal for providing the official form Difficulty of the 2013 and 2014 Lisbon World Cup.

REFERENCES

Agopyan, A. (2014). Analysis of Body Movement Difficulties of Individual Elite Rhythmic Gymnasts at London 2012 Olympic Games Finals. *Journal of Scientific Research, 19*(12), 1554-1565.

Ávila-Carvalho, L., Klentrou, P., Palomero, M. L., & Lebre, E. (2012). Body composition profile of elite group rhythmic gymnasts. *Science of Gymnastics Journal 4*(1), 21-32.

Ávila-Carvalho, L., Palomero, M. L., & Lebre, E. (2010). Apparatus difficulty in groups routines of elite rhythmic gymnastics at the Portimão 2009 World Cup Series. *Science of Gymnastics Journal, 2*, 29-42.

Bobo, B., & Sierra, E. (2006). *Estudio de las repercusiones de los cambios de código de puntuación en la composición de los ejercicios de gimnasia rítmica en la técnica corporal*. IV Congreso Internacional de la Asociación Española de Ciencias del Deporte.

Breitkreutz, T., & Hökelmann, A. (2012). *Performance analysis in individual competitions in rhythmic gymnastics*. World Congress of Performance Analysis of Sport IX University of Worcester.

Bucar, P., Cuk, I., Pajek, J., Kovac, M., & Leskosek, B. (2013). Is the Quality of Judging in Women Artistic Gymnastics Equvalent at Major Competitions of Different Levels? *Journal of Human Kinetics 37*, 173-181.

Caburrasi, E., & Santana, M. (2003). Análisis de las dificultades corporales en los Campeonatos Europeos de Gimnasia Rítmica Deportiva, Granada 2002 [www.efdeportes.com/efd65/grd.htm], *9*(65). Consulted 21-Nov-2016.

Čuk, I., Fink, H., & Leskošek, B. (2012). Modeling The final score in Artistic Gymnastics by different weights of difficulty and execution. *Science Gymnastics Journal 4*, 73-82.

Fernandez-Villarino, M., M, B.-A., & Sierra-Palmeiro, E. (2013). Practical Skills of Rhythmic Gymnastics Judges. *Journal of Human Kinetics, 39*, 243-249.

Ferreirinha, J., Carvalho, J., Côrte-Real, C., & Silva, A. (2011). *Evolução do Valor Real de Dificuldade dos Exercícios de Paralelas Assimétricas de Ginástas de Elite nos Ultimos Ciclos Olímpicos*. Communication presented in From Practice to Science: Formation, learning and training in gymnastics. Gymnastics Federation of Portugal.

FIG. (2012). Code of Points for Rhythmic Gymnastics: 2013-2016 [http://www.fig-gymnastics.com/site/page/view?id=472].

FIG. (2016). Apparatus Norms [http://www.fig-gymnastics.com/publicdir/rules/files/app-norms/Apparatus_Norms_I-III_2016-e.pdf].

Hökelmann, A., & Blaser, P. (2006). *Quantitative movement analysis of gymnastic performances in group competitions for qualitative assessment and for performance comparison*. WCPAS7 Berzsenyi Daniel College.

Hökelmann, A., Breitkreutz, T., & Liviotti, G. (2012). *Changes in performance structure during group competitions in rhythmic gymnastics*. World Congress of Performance Analysis of Sport IX University of Worcester.

Hökelmann, A., Liviotti, G., & Breitkreutz, T. (2013). Rhythmic Gymnastics. In P. O. D. a. J. S. Tim McGarry (Ed.), *Routledge Handbook of Sports Performance Analysis*. New York: Routledge.

Leandro, C., Ávila-Carvalho, L., Sierra-Palmeiro, E., & Bobo-Arce, M. (2015). Accuracy in judgment: The

difficulty score in elite rhythmic gymnastics individual routines. *Science of Gymnastics Journal, 7*(3), 81-93.

Leandro, C., Ávila-Carvalho, L., Sierra-Palmeiro, E., & Bobo-Arce, M. (2016a). Departure Difficulty Score Vs Final Difficulty Score. The Effect of Performance in Elite Rhythmic Gymnastics. *Athens Journal of Sports, 3*(3), 169-177.

Leandro, C., Ávila-Carvalho, L., Sierra-Palmeiro, E., & Bobo-Arce, M. (2016b). Technical content of elite Rhythmic Gymnastics. *Science of Gymnastics Journal 8*(1), 85-96.

Lebre, E. (1993). *Estudo comparativo das exigências técnicas e morfofuncionais em Ginástica Rítmica Desportiva*. Porto: Faculty of Sport - University of Porto. Doctoral thesis.

Lisitskaya, T. (1995). *Preparación coreográfica*. Barcelona: Deporte and Entrenamiento.

Massidda, M., & Calò, M. (2012). Performance scores and standings during the 43rd Artistic Gymnastics World Championships, 2011. *Journal of Sports Sciences, 30*(13), 1415-1420.

Oliveira, M. M. M. d., Lourenço, M. R. A., & Teixeira, D. d. C. (2004). Incidências de lesões nas equipes de Ginástica Rítmica da UNOPAR. *UNOPAR Cientifica Ciências Biológicas e da Saúde, 5/6*(1), 29-40.

Pelin, R. (2013). Studies Regarding The Rhythmic Gymnastics From The Olympic Games. *Sport si Societate: Revista de Educatie Fizica, Sport si Stiinte Conexe, 13*, 61-69.

Simões, G. (2000). *A avaliação do desempenho Docente.* Lisboa: Texto Editora.

Trifunov, T., & Slobodanka, D. (2013). The structure of difficulties in the routines of the best world and serbian rhythmic gymnasts. *Physical Culture, 67*(2), 120-129.

Vitrichenko, N., Klentrou, N., Gorbulina, N., Della Chiaie, D., & Fink, H. (2011). Rhythmic Gymnastics. Technical Manual. Level 3. . In FIG (Ed.). Lousanne: FIG Academy.

Corresponding author:

Amanda Batista
Sports Faculty
Porto University-Gymnastics
Rua da Arrábida nº 502 1ºandar hab. 06
Lordelo do Ouro Porto
Porto 4150109, Portugal
e-mail: amandabatistagrd@yahoo.com.br