TRENDS IN E AND D SCORES AND THEIR INFLUENCE ON FINAL RESULTS OF MALE GYMNASTS AT EUROPEAN CHAMPIONSHIPS 2005–2011

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Original research article

Abstract

The aim of the study was to investigate the trends in execution and difficulty scores of routines on all apparatus and in both qualification and final rounds of male European championships just before and during a 5-year period after the introduction of new "open-ended" Code of Points (CoP) in 2006. It was found that the new CoP solved the problem of invariant difficulty scores, most efficiently toward the end of the observed period (2011). Execution scores showed a clear decreasing trend, both in absolute value and also in it's ratio with difficulty score. A question arises, if the decreasing influence of execution on final score (and therefore ranking of competitors) is the desired outcome of the new CoP and future evaluation of gymnastic routines. It was also questioned if the decrease in execution score should be solely explained by the increase of difficulty (which probably means more deductions) and some minor changes in CoP after year 2006, or it showed (possibly unjustified) changes in applying the CoP.

Keywords*: Artistic gymnastics, European Championship, Males, Judging, E-score, D-score*

INTRODUCTION

As in several other "esthetic" sports, e.g. figure skating, diving, rhythmic gymnastics, and synchronized swimming, a score given to a competitor in artistic gymnastics also depends both on difficulty and the execution (flawlessness) of a routine. What part of the final score is given to each of these two components depends on sport rules (Čuk, Fink & Leskošek, 2012).

In artistic gymnastics a major revision of Federation Internationale de Gymnastique (FIG) Code of Points (CoP) occurred in year 2006. Old CoP (FIG, 1997; 2001) follow a "perfect 10" format, where a *start value* (SV) of 10 was the highest possible score of a routine, given to a gymnast with a "hard enough" routine with all *required* elements and no deductions in execution.

A new open-ended format was introduced in year 2006 and revised in year 2009 CoP (FIG, 2009). The final jury score is a sum of difficulty (D) score and execution (E) score, each of which is given by different panel of judges. The D score starts at 0 points and has no *upper* limit. Except for vault, where each element has it's own difficulty value (until 2011 the highest value given to a gymnast at EC was 7.0), the 10 most difficult elements are counted, each from 0.1 (A elements) to 0.7 (G elements). Each apparatus has four *element groups* designated as I, II, III, IV, and, except for floor exercise, a dismount

group designated as V. A gymnast is awarded 0.5 for each element group, if he performs at least one element from that group, no matter of its difficulty (except for the dismount where an element must be at least D to receive a 0.5 points). Additional points are awarded for connections of high valued elements. The E score starts from 10 (if at least 7 elements are performed) and has a lower limit of zero, but is usually around 9 points at major competitions (Olympic Games, World and continental championships, World cup).

Several other changes were introduced in the new (2006) CoP. Perhaps most influental for E score, deductions for small, medium and large errors and a fall changed from 0.1, 0.2, 0.4, and 0.5 (FIG, 1997) through 0.1, 0.2, 0.3, and 0.5 (FIG, 2001), 0.1, 0.3, 0.5, and 0.8 (FIG, 2006), to 0.1, 0.3, 0.5, and 1.0 (FIG, 2009), respectively. From year 1997 the upper limit of scale of difficulty was extended from super E (F) to G in year 2009 (FIG, 1997; 2009). Several other minor changes in the CoP were introduced in year 2009, e.g. E jury score deductions for too short exercises. In concordance with Boen, Van Hoye, Auweele, Feys, & Smits (2008), who found open feedback causes conformity bias in judges' scores, after year 2009 only final E jury scores (i.e. average E jury score of middle four judges) are displayed to the public and later published in the official results.

Several gymnasts, coaches and officials opposed CoP changes in year 2006, especially omitting the traditional 10.0 points format. Although analysis of officiating some major gymnastics events held after 2006 showed metric characteristics (reliability, validity) are generally acceptable (Bučar, Čuk, Pajek, Karacsony & Leskošek 2011; Leskošek, Čuk, Pajek, Forbes & Bučar Pajek, 2012), some other problems arose, which may or may not originate from CoP changes. Thornton (2010) noted, the *highest* execution score given in the both men and women event final contested at the World Championships or Olympic Games between 2006 and 2009 shows a clear trend of declining and 2009 scores seem to be "trapped" between an 8.5 and a 9.0 points regardless of the performance. Thornton found little justification of this trend in rules changes (apart from women's floor) and speculates the problem lies in *application* of those rules.

The purpose of this paper is to quantify trends in E and D scores in the last year before rule change (2005) and in period after that (2006-2011) at male European Championship as one of the most important gymnastic competitions and possibly find reasons for those changes and their consequences.

METHODS

Data: All E and D scores from Competition I (qualification) and III (apparatus finals) were retrieved from FIG officials and Internet (Longines timing 2008, 2010, 2011). 2007 scores are missing as they are not published on the FIG Internet site and authors were not able to obtain them from UEG officials. Additionally, 4 routines with zero final scores (all from vault, 3 from qualification and one from apparatus finals) were excluded.

Data analysis: The E score was computed as (10–deductions–penalties) for period after 2005. In 2005, E deductions were computed as (Start value-Final score). D score in 2005 was computed as (Start value–4) to make this score more comparable with D scores in 2006-2011. From so defined E and D scores, the gap behind the best E and D scores for each apparatus, session and year (competition) were computed. Basic distributional parameters of E and D scores and their ratios and gaps behind the best score were computed and plotted.

RESULTS

The number of competitors in the qualification round (Table 1) is different between years 2005 and 2011 and on different apparatuses, but it mostly ranges

between 80 and 100, except for 2010 where it is slightly lower. The number of competitors that perform also the second vault varies from 13 (2010) to 35 (2005). The scores from both vaults were joined before the further analysis. In apparatus final, on all apparatus eight gymnasts competed and on vault all perform two vaults except for 2007 where one of the competitors performed only one vault (for the second he received a score of zero, which was excluded from analysis).

Table 1. *Number of competitors in qualification round by year and apparatus.*

	Year						
Apparatus	2005	2006	2008	2009	2010	2011	Total
Floor	87	87	96	87	75	94	526
Pommel horse	89	92	100	84	73	94	532
Rings	95	88	96	83	77	93	532
Vault 1	86	85	96	80	73	86	506
Vault 2	35	23	26	33	13	27	157
Parallel bars	86	93	99	79	76	92	525
High bar	94	88	97	80	76	89	524
Total	572	556	610	526	463	575	3302

Although some irregularities exist, there is a general tendency of an increase in difficulty score and a decrease in execution scores between 2006 and 2011 (Table 2, Figure 1). This is not only true for the central tendency (median, mean) of scores, but also for maxima. In the year 2011, in both sessions and on all apparatus (except for a tie on parallel bars in qualification), the E score was lower than in the first year after the major rules change (2006); in the D score, in only 2 out of 12 cases, lower scores were observed in 2011 than in 2006. In 2005, the last year of closed-ended system, many routines were awarded the highest possible score for difficulty, i.e. a start value of 10; e.g. in 2005 apparatus finals, three out of 16 vaults and 22 out of 40 routines on other apparatus were given this value. In most cases the decrease in E score was higher than the increase in D score, resulting in a weak trend of decreasing final scores (Figure 1).

In most cases differences (variability) between competitors in both E and D score increased in the period 2006-2011 compared to 2005, while there is no clear trend in variability change within the period 2006-2011 (Table 2, Figure 1).

Although E scores remained higher than D scores, the ratio between them has decreased between 2005 and 2011. Although the ratio is much higher in qualification sessions than in apparatus finals, this decrease is similar on all apparatus, i.e. from around 1.5 to 1.8 in the qualification round and from around 1.3 to 1.6 in apparatus finals (Figure 2). Extremely high variability in same cases is mostly due to single extreme outliers (most notably in rings qualifications in 2006, where one of the competitors received a D score of 1.0 and E score of 8.925), which probably arose from too short of an exercise that was penalized only after the revision of the CoP in year 2009.

At the beginning and at the end of the observed period, i.e. in years 2005 and 2011, in qualification sessions, competitors are much more heterogeneous in the D score than in the E score, while in apparatus finals in 2005 and 2011 the situation is the opposite, most notably on rings in 2005 where all but one finalists had the same D score, i.e. start value of 10 (Table 3). In intermediate years (2006-10) the variability in the D score is, especially in apparatus finals, only slightly higher than in the E score.

Table 2. *Medians, interquartile ranges and maxima of D and E score by year of competition, session and apparatus.*

		Year of competition																	
		Median						Interquartile range						Maximum					
		05	06	08	09	10	11	05	06	08	09	10	11	05	06	08	09	10	11
		Difficulty score																	
Qualification	Floor	5.00	5.40	5.40	5.50	5.40	5.50	.80	.90	.98	.80	1.00	.90	6	6.6	6.5	6.4	6.7	6.7
	P.horse	5.30	5.10	5.15	5.30	5.20	5.20	.90	.88	1.20	.90	1.10	1.13	6	6.3	6.5	6.8	6.7	6.9
	Rings	5.10	5.20	5.30	5.50	5.30	5.40	1.20	1.38	1.30	1.10	1.05	1.20	6	7	7.3	6.9	6.8	6.8
	Vault	5.70	6.60	6.20	6.20	6.20	6.20	.50	.60	1.20	.80	.80	.80	6	7	7	7	7	7
	P.bars	5.00	5.10	5.50	5.50	5.20	5.55	.83	1.10	1.20	1.00	1.10	1.00	6	6.5	6.7	6.5	6.5	6.7
	H.bar	5.10	5.50	5.40	5.40	5.40	5.70	.90	.98	.85	1.00	1.08	1.20	6	6.4	7	6.9	7	7.2
Apparatus finals	Floor	5.85	6.15	6.15	6.25	6.40	6.40	.17	.35	.45	.25	.43	.37	6	6.4	6.6	6.5	6.7	6.7
	P.horse	6.00	5.70	6.20	6.50	6.30	6.40	.15	.83	.30	.27	.43	.68	6	6	6.7	6.7	6.7	6.7
	Rings	6.00	6.55	6.70	6.70	6.50	6.70	.00	.85	.75	.18	.78	.18	6	7.1	7.3	7	6.8	6.8
	Vault	5.90	6.80	7.00	6.60	6.60	7.00	.00	.15	.40	.40	.00	.35	6	7	7	7	7	7
	P.bars	5.80	6.25	6.60	6.20	6.05	6.00	.75	.40	.40	.50	.43	.18	6	6.4	6.7	6.5	6.5	6.7
	H.bar	6.00	6.15	6.60	6.55	6.85	6.65	.25	.45	.48	.60	.35	1.00	6	6.3	7	7	7.1	7.7
		Execution score																	
Qualification	Floor	9.26	8.70	8.50	8.40	8.25	8.34	.35	.73	.72	1.15	.63	.88	9.675	9.425	9.225	9.2	9.125	9.125
	P.horse	9.14	8.21	8.20	7.73	7.90	7.53	.58	1.06	1.13	1.16	1.23	1.24	9.75	9.5	9.425	9.2	9.025	9
	Rings	9.25	8.43	8.35	8.15	8.23	8.00	.32	.69	.52	.87	.74	.85	9.712	9.15	9.075	8.925	8.85	8.875
	Vault	9.51	9.40	9.23	9.08	8.98	9.15	.29	.34	.41	.89	.51	.39	9.75	9.8	9.575	9.575	9.45	9.6
	P.bars	9.28	8.85	8.58	8.58	8.33	8.51	.49	.66	.60	.80	.85	.70	9.587	9.525	9.525	9.55	9.125	9.525
	H.bar	9.21	8.88	8.28	8.25	7.83	8.18	.43	.68	.64	.79	.92	.75	9.675	9.575	8.925	9.1	8.625	8.975
Apparatus finals	Floor	9.47	9.16	8.84	8.94	8.73	8.90	.44	.40	.43	.21	.14	.86	9.637	9.275	9.25	9.15	8.95	9.2
	P.horse	9.58	8.64	9.04	8.69	8.54	8.43	.42	.82	.73	1.65	.54	1.36	9.775	9.45	9.325	9.05	8.9	8.925
	Rings	9.63	9.05	8.81	8.76	8.25	8.80	.16	.28	.43	.36	.46	.52	9.712	9.425	9.2	9.15	8.575	9.15
	Vault	9.65	9.43	9.41	9.30	9.30	9.04	.06	.23	.25	.15	.31	1.11	9.762	9.725	9.6	9.45	9.475	9.5
	P.bars	9.51	9.21	9.14	8.94	8.94	8.85	.88	.41	.34	.38	.30	.37	9.712	9.625	9.425	9.325	9.1	9.3
	H.bar	9.65	8.78	8.38	8.23	8.30	8.06	.46	1.31	1.00	.91	.50	.66	9.75	9.425	9.05	8.675	8.5	8.775

Table 3. *Interquartile range for the ratio between D and E score by year of competition, session and apparatus.*

		Year					
Session	Apparatus	2005	2006	2008	2009	2010	2011
Qualification	Floor	2.29	1.24	1.36	.70	1.60	1.03
	P. horse	1.55	.83	1.06	.78	.90	.91
	Rings	3.69	1.98	2.51	1.26	1.42	1.41
	Vault	1.70	1.78	2.91	.90	1.58	2.06
	Parallel bars	1.69	1.66	2.00	1.25	1.29	1.43
	High bar	2.10	1.44	1.33	1.26	1.17	1.60
	(average)	2.17	1.49	1.86	1.02	1.33	1.41
Apparatus finals	Floor	.40	.88	1.04	1.21	2.96	.43
	P. horse	.35	1.00	.41	.17	.78	.50
	Rings	.00	3.02	1.76	.49	1.70	.34
	Vault	.00	.67	1.60	2.67	.00	.32
	Parallel bars	.85	.97	1.16	1.33	1.42	.47
	High bar	.54	.34	.48	.66	.70	1.51
	(average)	.36	1.15	1.08	1.09	1.26	.60

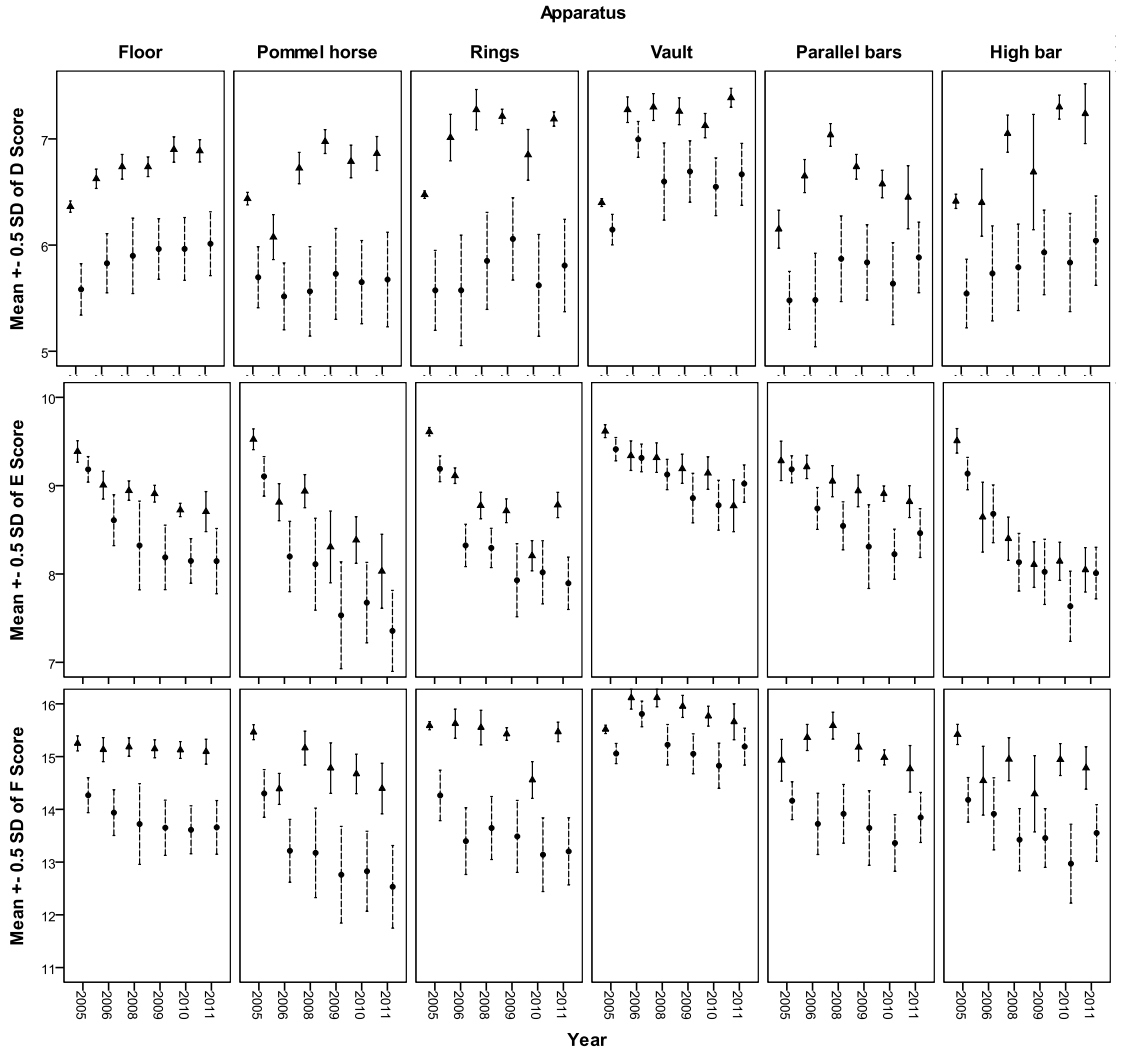

Figure 1. *Error bars (mean ± 0.5 standard deviation) of difficulty, execution and final scores at European Championships 2005-2011 by session (solid line=apparatus finals, dashed line=qualification), year and apparatus.*

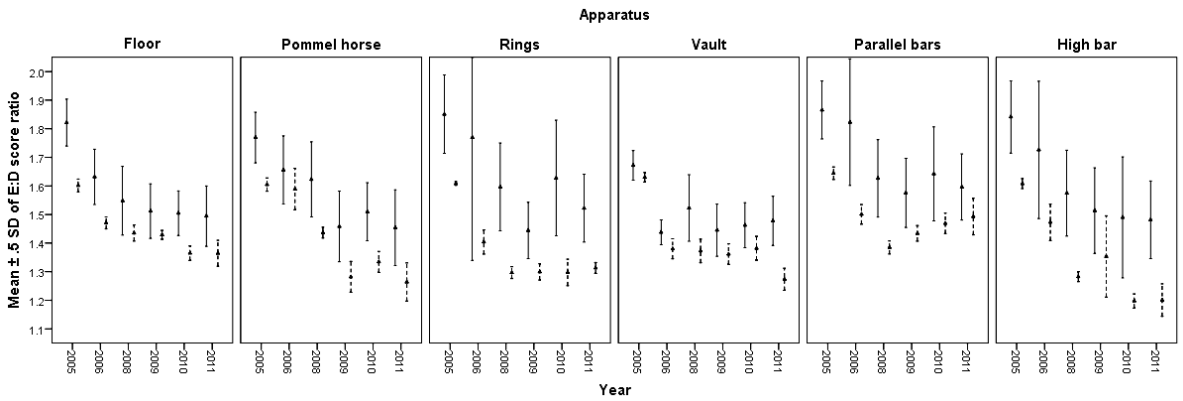

Figure 2. *Error bars (mean ± 0.5 standard deviation) of execution/difficulty scores ratio at European Championships 2005-11 by session (solid line=apparatus finals, dashed line=qualification), year and apparatus.*

Table 4. *Pearson correlation coefficients between D in E score by session, apparatus and year of competition.*

Session	Apparatus	Year 2005	2006	2008	2009	2010	2011
Qualification	Floor	.43	.17	.58	.29	.38	.14
	Pommel horse	.56	.39	.62	.56	.60	.50
	Rings	.61	.29	.48	.45	.38	.49
	Vault	-.04	.12	-.11	-.12	.20	-.06
	Parallel bars	.37	.42	.33	.44	.26	.21
	High bar	.34	.55	.29	.05	.51	.10
	(All)	.47	.52	.50	.43	.48	.43
Apparatus finals	Floor	.23	.65	.21	.66	.29	-.13
	Pommel horse	.20	-.03	.83	.55	.58	.22
	Rings	.73	.54	.86	-.47	.42	.48
	Vault	-.05	.08	-.32	.01	-.27	.42
	Parallel bars	.93	.47	.61	.53	-.18	.69
	High bar	.68	.68	.89	.57	.65	.14
	(All)	.70	.57	.40	.38	.11	.15

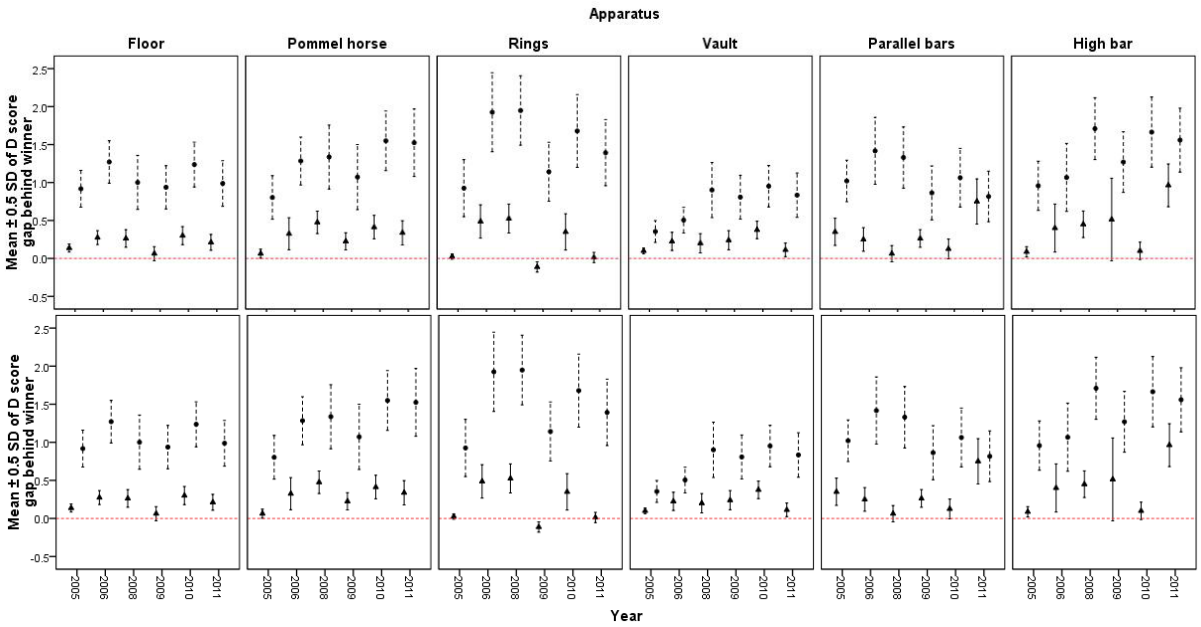

Figure 3. *Error bars (mean ± 0.5 standard deviation) of lag (gap) of E and D score behind the competitor with the highest final score (red dashed line) by session (solid line=apparatus finals, dashed line=qualification), year and apparatus.*

Table 5. *Proportion (in qualifications) and number of competitors (in apparatus finals) that received higher E or D score than the "winner" (competitor with the highest final score in particular session).*

		D score Year						E score Year					
Session	Apparatus	05	06	08	09	10	11	05	06	08	09	10	11
Qualification	Floor			1%			2%		1%	2%	2%		7%
	Pommel horse			2%	12%		1%						1%
	Rings				4%		2%		1%			14%	
	Vault								3%	2%	3%	24%	2%
	Parallel bars		1%		4%	1%	3%	6%		1%			2%
	High bar		1%		3%		1%			1%		1%	10%
	Total	0.0%	0.4%	0.5%	3.4%	0.2%	1.6%	0.9%	0.9%	1.0%	1.0%	7.1%	3.7%
Apparatus finals	Floor			1	2		1		2	1			3
	Pommel horse		2						1		2		
	Rings		1		5	1	3					1	
	Vault										1	3	
	Parallel bars			3		2						1	5
	High bar				1	2				1			5
	Total	0%	5%	7%	15%	9%	7%	0%	5%	4%	5%	14%	23%

Except for the vault, a general tendency exists that competitors with a higher D score also received a higher E score (Table 4). While the correlation between D and E in qualification session score is of moderate height (around .5) throughout the period 2005-2011, in apparatus finals this correlation has become lower and is almost non-existent in the last two years (2010, 2011).

The gap of D and E scores behind the winners (competitors with highest final score) of each event (session) was generally smaller in 2005, but later seems to have no systematic trend (Figure 3). In 2009, however, the gap behind the D scores tend to be somewhat lower, while the gap behind E scores tend to be somewhat higher than in years before and after 2009. Winners usually received the highest scores both for difficulty and execution (Table 5). Exceptions were rare at the beginning of 2005-2011 period and became more frequent at the end, especially in E scores at apparatus finals, where in parallel bars and high finals bar at 2011 EC only two of 8 finalists received lower E scores than the winner.

DISCUSSION

Although the start value (SV) in 2005 is not directly comparable to the difficulty score, it's obvious that the difficulty of routines at EC is increased constantly in the period 2005-2011. This is true not only for mean or median D scores but also for maxima D scores. Somewhat specific in this context is vault, as mean scores were similar and maxima scores were the same in the period 2006-2011.

On the other hand, E scores is generally decreased from 2005 to 2011. The latter finding is in agreement with Thornton (2010), who found a similar trend in *maxima* E scores at World Championships and Olympics Games from 2006 to 2009. In contrast to Thornton, however, no evidence was found that E scores are being "trapped" between 8.5 and 9, namely, the variability (as measured with interquartile range) of E scores is higher in 2006-2011 than in 2005

and between 2006 and 2011 even showed a vague trend of increasing. Again, vault is somewhat specific, as it has generally high E scores with small variability, but interestingly shares the trend of decreasing mean E scores with other apparatuses, despite that the D score is not increasing on this apparatus.

The drop of E scores and increase in D scores may also indicate that the difficulty of routines in the 2005-2011 period were probably increasing even more as indicated by the increase in D scores, as it seems that in many cases the flaws in *execution* of elements resulted not only in deductions in E-scores but also in non-recognition of the difficulty of those elements.

The drop in E score between 2005 and 2006 could probably be explained in great part by rule changes, i.e. increasing the deductions from 1, 2, 3 tenths of a point to 1, 3, 5 tenths for small, medium or large errors, respectively, and increasing the deductions for a fall from the apparatus from 0.5 points in 2005 to 0.8 in 2006-2008 and 1.0 point in 2009-2011. However, the reasons for the drop in E scores between 2006 (the first year after introduction of the new CoP) and 2011 is less clear, and could not be explained solely by an increase in D scores; specifically, the drop in E scores was bigger than the increase in D scores, resulting in a weak trend of decreasing final scores. If one assumes that the performance of gymnasts is improving over time, this decreasing trend in final score is quite contrary to what one would expect. As there were probably no important rule changes in the CoP between 2006 and 2011 (apart from an increase in the deduction for a fall from 0.8 to 1.0 point), it is reasonable to speculate that the decrease in final scores is at least partly a result of changes in *applying* the code. Since there is rarely a doubt of the fair application of rules for the difficulty of the routines, changes probably occurred in more rigorous or more frequent deductions for routine execution. Considering the latter, it's worthwhile to notice the opinion, that officiating by the current rules is so demanding, that execution can no longer be accurately measured by human eyes (Thornton, 2010). In addition, it seems that judges are afraid of not noticing some errors and therefore make more deductions than they actually see; typical in that sense is the statement of one the most experienced brevet judges, who awarded Xiao Qin's routine in qualification on pommel horse with an E score of 10, the only one at the World Championship in Anaheim 2003, as he saw no errors, but he "... was tempted to take a .10 deduction because I suspected that none of the other judges would be prepared to go out on a limb and award a perfect score" and "When you have a very strong performance (higher than 9.5), you are only allowed a .20 deviation from the final score or your score is considered 'out of range'. This means that for exceptional performances, the safe score is a 9.8. This gives you a full .40 range in your score. If you award a 10.0, the average has to be 9.8 or higher ... I think that most judges, recognizing this, are reluctant to give a score much above 9.8" (Turner, 2003).

As a result of decreasing E scores and increasing D scores, the ratio between those two scores also decreased in the period 2005-2011. Although the E score is even at the end of this period around 1.5 times higher than the D score, it's probably wrong to conclude, that the E score is more *important* for the final score than the D score. Namely, what decides the winner is not an absolute value, but the variability of E and D scores, which is similar or sometimes even higher in D than in E scores. The probable higher importance of the D score may also be seen in the gaps between competitors' E and D scores behind the winner (i.e. the competitor with the highest final score in each session); in qualification sessions those gaps are even higher in D scores than in E scores; however the difference between E and D score gaps was found similar (around 0.3 points in qualifications and around 0 points in apparatus finals) throughout the observed period.

E and D scores are modestly correlated in qualification sessions in all competitions

from 2005 through 2011, while in apparatus finals they decreased from 0.7 in 2005 to almost no correlation in 2010 and 2011. The decreasing correlation in apparatus finals is probably due to increased difficulty of routines resulting in more deductions, and probably also in the higher risk competitors are willing to take in order to take the winning positions. It should also indicate the shift in focus of preparation for major gymnastic events, namely from perfect execution of "hard enough" routine to hardest routine possible with "reasonable risk" for "not-too-large" deductions for flaws in execution.

CONCLUSIONS

Although the design of the study (i.e. observational, not randomized) does not allow to exactly quantify the influence of rule change from old, close-ended ("perfect 10") rules that were valid until 2005 to the new open-ended rules (introduced in 2006 and revised in 2009), some trends are quite obvious. The difficulty of routines generally increased in the period 2005-2011, probably even more than is indicated by the increase in the D score itself. On the other hand, the E score decreased in the observed period. There is no doubt that the new rules efficiently solved the problem of almost invariant D scores: in 2005, most of the finalists had equal or at least very similar start values, while afterwards the variability of D scores (and gaps behind the winner's D score) was much higher.

According to these results it's not possible to unequivocally evaluate the influence of the new rules on gymnast's performances as "bad" or "good" as this evaluation depends on what someone expected from the new rules. Although many may agree that trends found in this study are positive, they are probably contrary with some expectations that caused or at least initiated the introduction of the new rules, e.g. the expectation that the new rules will prevent the cases of "sacrificing execution for difficulty" (as seen at 2004 Olympics in Athens).

The study also showed that the changes in scores are probably not only due to changes in the code itself but also to changes in *applying* the code. In this sense someone may agree with the arguments of "stricter judging" trends as made by Thornton (2010). This and some other statements (e.g. of judge Grabowecky following Anaheim 2003) confirm the thesis, that judges are not only unable (partly because of complicated rules) to judge in accordance with the code, but sometimes also make "adjustments" of their "fair" scores in order to stay within allowed deviations from the final score. It seems that the ultimate goal of the E-score given by a judge is not to simply to sum up the actual flaws that they *see* in the execution of the routines, but also to speculate what *other* judges have seen *and* how many *additional "strict judging"* points *other* judges would subtract from this "initial" E-score. Although this study is unable to scientifically confirm this thesis it seems that it's worthwhile to do this in another study as it may supply the strong arguments for rule changes and the introduction of "real time judging" systems.

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Acknowledgement: authors are grateful to Gianfranco Marzolla, UEG MTC president who helped authors with EC results.