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GIANT SWINGS WITH TURNS COMPLETED TO HANDSTAND ON UNEVEN BARS

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This study investigated the technical features of successful turn to handstand performance during giant swinging skills on the uneven bars in Women's artistic competition. The uneven bar performances of the top five nations at the 2010 Pacific Rim Championships was videoed from the side. All giant and Stalder turn performances, 180^0 'blind change' and 360^0 'blind full', were assessed post competition to identify the discrete angles at turn start, the first hand grip change, and turn end. The turn end position was also judged using Article 7.4.4 of the Code of Points to determine any execution deductions. The turn start position for the four skills analysed suggest that there may be an optimum angle window for the turn start of 50-60^0, with the position of the first hand release largely dependent on the swing skill and the turn displacement required.

KEY WORDS: gymnastics, circle element, Stalder, women, artistic, performance.

INTRODUCTION: Uneven parallel bars require a natural flow pattern of swinging with precise timing between loading and unloading the bar. This is required in order to execute closed loop and flight skills on the low and high bar whilst maintaining tight, technical form and maximising amplitude (George, 2010). Movement on the bars is predominantly executed using two planes; movement in the sagittal plane such as the giant swing where the axis is the horizontal bar, and turning (rotation 'twisting') movements that occur in the transverse plane where the axis extends through the centre of the gymnasts body from the top of the head through to their feet (Pidcoe et al., 2011). In the case of bar initiated turns where the gymnast is in contact with the bar during sagittal plane motion (e.g. giant swing circle where the gymnast travels around the high bar in a relatively extended, handstand-like body position), a turn can be initiated using a hip movement or tap swing and then by releasing and re-grasping the bar one hand at a time in a quick sequence.
A blind change is one specific 180^0 turn technique that is initiated from a forward (over) grip to a reverse (under) grip. Whereas a blind full is a 360^0 turn technique from forward grip to a reverse grip and then back to a forward grip. Both skills allow the gymnast to maintain the same sagittal plane rotation throughout the skill. These challenging bar skills enable gymnasts to build their difficultly (D) score, therefore increasing the gymnasts start score. However, a difficult and potentially higher scoring routine must also be executed with sufficient amplitude and technical execution to avoid point deductions (E score). The giant and Stalder circle with turns, for example, is judged from vertical handstand to handstand on top of the high bar (Daniels, 1983). Technical success is credited when the handstand turn has been completed within 10 degrees of the vertical plane on the upper bar (FIG, 2009), which is judged subjectively during the live performance by a panel of judges. These skills can also be connected to flight skills such as the Tkatchev in order to further increase the difficulty of the routine.
The purpose of this study was to investigate the technical features of successful turn to handstand performance during swinging skills on the uneven parallel bars in Women's artistic international level competition. It was hypothesised that there would be an optimal angle range for turn commencement and first hand movement required to successfully perform a handstand pivot within 10 degrees of the vertical.

METHODS: The uneven parallel bar performances of the top five nations during the first session of competition (combined all-round and team) were videoed during the 2010 Pacific

Rim Championships using one Samsung digital camera (VP-HMX20C, 50 fps, Japan, 1/500 s) positioned in the grand stand, side-on to the apparatus. Due to filming restrictions from spectator seating sales, the uneven bar routines were filmed from the opposite side to the judging panels view. A total of 24 uneven bar performances by gymnasts whom represented Australia, Canada, China, Russia, and the United States of America (USA) were videoed. Each team comprised of up to three junior and three senior gymnasts aged a minimum of 14 and 16 years respectively (or becoming age eligible that calendar year).
All video was assessed post competition using Swinger Motion Analysis Software (Websoft Technologies, Scoresby, Melbourne, Australia) to identify blind change and blind full pivots on the high bar during a giant or Stalder circle. Where an individual competitor performed the same skill twice, the first attempt during the routine was selected for kinematic analysis.

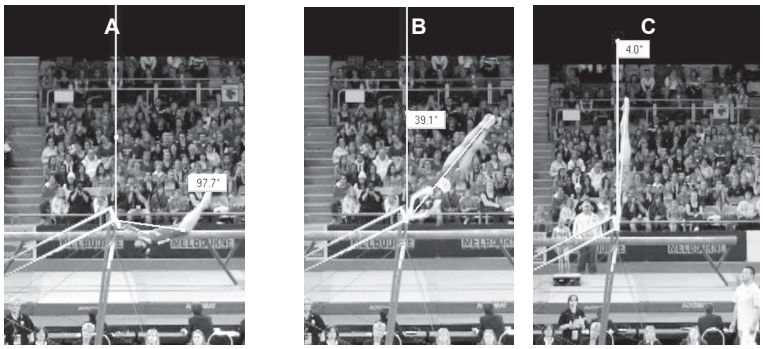
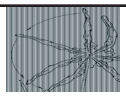


Figure 1: The points of interest that was assessed for the turn skills. This example shows a gymnast executing a giant circle with a blind change ('blind change') at (a) turn start, (b) first hand release, and (c) turn end.

Each of the four bar skills were analysed to determine the angle with reference to the vertical plane where the turn about the gymnasts long axis started (also known as a twist; Figure 1a), where the first hand was released (Figure 1b), and at the end of the turn (Figure 1c). Due to body position differences between swing circle skills (giant or Stalder swing) for the turn start, the hand grip to hip (greater trochanter) segment angle was analysed. The turn start commences with hip rotation. For the remaining positions the body was extended regardless of the skill being performed and therefore, the hand grip to toe angle was assessed. The analysis of the turn start (hand to hip) and remaining body positions (hand to toe) was consistent with judging methods of observation. To normalise the angles to account for swing direction, all angles for the upswing movement were converted to a positive angle with reference to the vertical. If the gymnast went over the top of the high bar before finishing the turn skill, the final angle was recorded as a negative value. Angular displacement was calculated as the difference between turn start and turn end.
The turn end angle was used to judge whether performance of the turning skill was successful or unsuccessful, consistent with the Article 7.4.4 of the Federation Internationale de Gymnastique Code of Points 2009. Briefly, there is an execution score deduction (from a maximum of 10.0) if the turn is finished on the high bar in a handstand, outside of 10^0 either side of the vertical plane (deductions: $>10^0$-30^0 = 0.10 points, $30^0 – 45^0$ = 0.30 points, $>45^0$ = 0.5 points). Further technical execution deductions for body faults (e.g. feet crossed) and a lack of amplitude were not considered in this study.
All discrete angular kinematic data for each skill was collated in an Excel spreadsheet (Office 2007, Microsoft, California, U.S.A.) and then transferred to the Statistical Packages for the Social Sciences (Version 18.0, IBM, Somers, New York) for statistical analyses that included Pearson's correlation analyses between turn start, first hand release, turn end, angular displacement, and E panel deductions. Statistical significance was set at an alpha level of 0.05 for all analyses.

RESULTS AND DISCUSSION: The number of performances for each skill are summarised in Table 1. The simplest blind change skill that has a difficulty rating of B had the highest technical success rate of 92% and was performed by at least one competitor from each country. Whereas the blind full, a C skill, which was not performed by any of the competitors from China or Russia, was performed less frequently and had a 0% technical success rate. Interestingly, the two Stalder skills were not performed by any of the competitors from China. The Stalder blind change, a C skill, had a lower performance frequency, and had a 63% technical success rate. The Stalder blind full D skill was attempted by a higher number of competitors (n=13) but had a low technical success rate of 15%.

Table 1
The uneven parallel bar skills selected for analysis from the competition. All skill descriptions and illustrations are from Federation Internationale de Gymnastique Code of Points 2009. The difficulty ratings are graded from A (easiest) to G (hardest). A successful performance was identified when the turn was completed on top of the high bar within 10 degrees of the vertical plane.

Common Name	Skill					Competitors (n)	Countries Represented (n)	Successful (%)
	Group	Code	Definition	Illustration	Difficulty			
Blind Change	Giant Circles	3.201	Giant circle backward with 1/2 (180^0) turn to handstand		B	12	5	92
Blind Full	Giant Circles	3.301	Giant circle backward with 1/1 (360^0) turn to handstand		C	6	3	0
Stalder Blind Change	Stalder Circles	4.301	Stalder forward with 1/2 (180^0) turn to handstand		C	8	4	63
Stalder Blind Full	Stalder Circles	4.401	Stalder forward with 1/1 (360^0) turn to handstand		D	13	4	15

The execution (E) score penalty points (if any) for each skill and the discrete angular kinematic results are provided in Table 2. Both of the blind full skills (360^0 turn) had high average E score deductions due to the turn (twist) ending in the handstand position approximately 20^0 degrees after the target zone (turn end – blind full: mean =-29 ± 15^0, Stalder blind full: mean = -31 ± 19^0). Across all of the skills there was a positive correlation between the turn start position and the first hand release position (r=0.42, p=0.010). There was also a negative correlation between first hand release position and angular displacement (r=-0.67, p=0.001) and a positive correlation between angular displacement (turn start to end) and turn end angle (r=0.54, p=0.001). This suggested that the 180^0 or 360^0 turn should be initiated later in the upswing (closer to the vertical plane), with the turn occurring during a smaller angular range. However the turn start position data for the four skills suggest that there may be an optimum angle window for the turn start of approximately $50\text{-}60^0$, with the position of the first hand release largely dependent on the swing skill (giant or Stalder circle) and the turn displacement required. Table 3 displays a breakdown of the different levels of performance (0.0 to 0.5 penalty points) for three of the skills (Blind Full skill excluded), which provides some insight on this performance aspect.

Table 2
The discrete angular kinematic results for the four skills assessed on the uneven parallel bars and the execution (E) score penalty points.

Common Name	Turn Start (^{0})				First Hand Release (^{0})				Turn End (^{0})				E Panel Deduction (pts)			
	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max
Blind Change	53	19	25	84	37	9	15	48	-5	7	-19	8	0.08	0.03	0.0	0.1
Blind Full Stalder	70	8	63	85	41	6	32	51	-29	15	-51	-11	0.23	0.16	0.1	0.5
Blind Change Stalder	56	20	31	91	13	4	7	22	-8	6	-16	-2	0.04	0.05	0.0	0.1
Blind Full	37	10	19	51	13	5	2	21	-31	19	-59	1	0.25	0.18	0.0	0.5

Table 3
A comparison between E score deductions and discrete angular kinematics for the three skills that were successfully executed by at least two competitors in the competition. The blind full is excluded from this table due to its 0% performance success rate.

Common Name	E Panel Deduction (pts)	Competitors (n)	Turn Start (^{0})		First Hand Release (^{0})		Turn End (^{0})	
			Mean	SD	Mean	SD	Mean	SD
Blind Change	0.0	11	50	17	38	9	-4	6
	0.1	1	84		31		-19	
Stalder Blind Change	0.0	5	46	14	14	6	-5	4
	0.1	3	70	21	13	1	-13	2
Stalder Blind Full	0.0	2	49	2	12	6	-1	4
	0.1	3	46	6	13	3	-19	3
	0.3	4	27	6	12	7	-36	4
	0.5	3	33	2	17	1	-56	2

CONCLUSION: This study identified a potential upswing turn start angle window that warrants further investigation using inverse dynamic modelling techniques (e.g. see Hiley & Yeadon, 2005). E score point deductions can compound over an uneven bars routine due to technical execution errors identified at turn completion, and therefore can have a significant impact on performance score. However this assumes that judges are able to accurately judge turn performance with reference to the vertical plane. Further research is warranted on the accuracy of this aspect of judging.

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