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A mixed method analysis in artistic swimming: Time motion, lag sequential and polar coordinates analysis

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- ## Introduction and purpose

The aim of this study was to analyze the relationships between apnea and body positions in the elite routines of solo artistic swimming using mixed methods: lag sequential analysis, polar coordinate analysis and a quantitative comparison of the times in each position.

- ## Method/Design

We employed a nomothetic, point, multidimensional observational design. Data were recorded using an observation instrument designed ad hoc and the LINCE, HOISAN and GSEQ5 programs. Participants were 15 female swimmers, and 22 routines were analyzed: technical solos (TS) (n = 10), free solos (FS) (n = 12). A t-test for independent samples was used for comparison between routines.

- ## Results

Apnea situations, swimmer's body orientation in water, face immersion and body immersion level were recorded. The swimmers of TS were 72.4 ± 5.9% of the routine time in apnea, while in FS it was 65.7 ± 4.8% (p <.05). Apnea was determined as given and focal behavior. The lag sequential analysis in lag 0 presented significant inhibition or excitation values in almost all behaviors in a similar way for TS and FS.

Table 1: Temporal distribution of solo routines

	Technical Solo (n = 10)			Free Solo (n = 12)			Significance (p value)
Score (points)	91,1	±	3,9	90,9	±	4,1	0,937
Routine (s)	130,5	±	3,0	184,4	±	5,7	0,000*
Beach phase (%)	2,9	±	1,3	2,4	±	0,5	0,228
Air phase (%)	0,3	±	0,1	0,2	±	0,0	0,002*
Aquatic phase (%)	24,3	±	5,3	31,6	±	4,9	0,003*
Underwater phase (%)	72,4	±	5,9	65,7	±	4,8	0,008*
Face-in (s)	89,8	±	7,0	110,8	±	9,0	0,000*
Face-in (%)	68,8	±	5,8	60,1	±	5,1	0,001*
Face-in elements> 10 " (n)	3,6	±	0,8	4,1	±	1,0	0,239
Face-in elements> 10 " (s)	54,2	±	9,9	65,2	±	14,2	0,052

Values are mean ± SD
* Significant differences between Technical Solo and Free Solo (p <0.05).

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Table 2: Lag sequential (lag 0) of Free and Technical Solo

	Technical Solo Lag 0	Free Solo Lag 0
Apnea		
Face In	27,21	34,24
Face Out	-27,21	-34,24
Corporal position		
Horizontal position	-2,96	-5,87
Bottom position	10,48	15,11
Top position	-6,76	-8,16
Corporal immersion		
Low immersion - Horizontal position	0,33	-0,96
Low immersion - Top position	3,54	5,78
Low immersion - Bottom position	-8,19	-6,31
High immersion - Horizontal position	-3,63	-7,52
High immersion - Top position	8,6	11,86
High immersion - Bottom position	-7,09	-9,19
0% immersion	-11,96	-13,1
100% immersion	9,8	12,05

The polar coordinate analysis also presented very similar patterns in both types of routine with significant vectors in the same quadrants, except for the behaviors related to all low immersion levels.
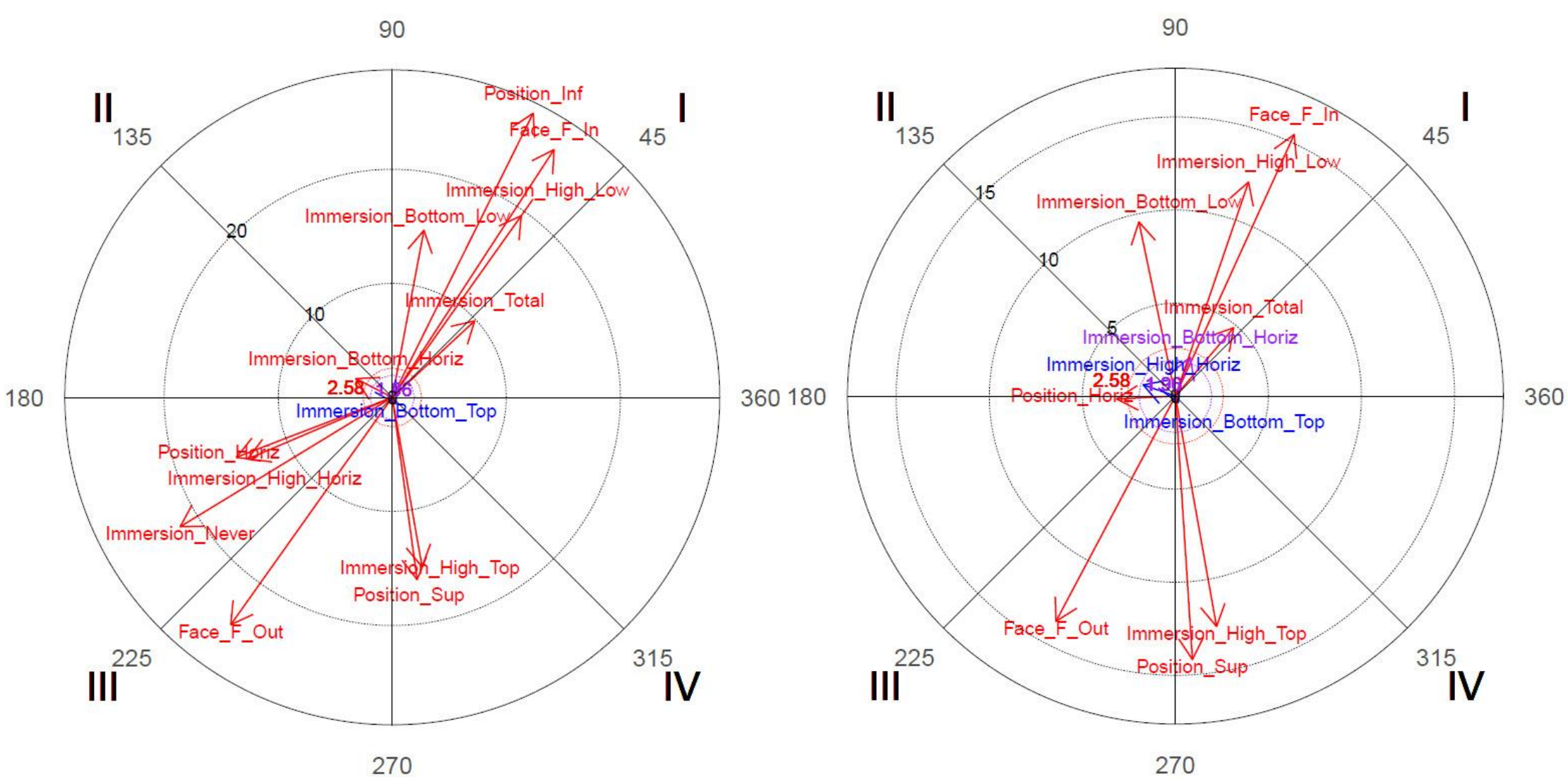

Figure 1: Polar coordinates of Free Solo (left) and Technical Solo (right)

- ## Conclusions

In conclusion, there are significant differences in the total duration of apnea episodes, but in most body positions performed during the routine there are similar synchronous and diachronic relationships in the two solo modalities.