Variability in pacing strategies along race performance of swimmers with intellectual impairment at the Paralympic Games

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VISTA CONFERENCE

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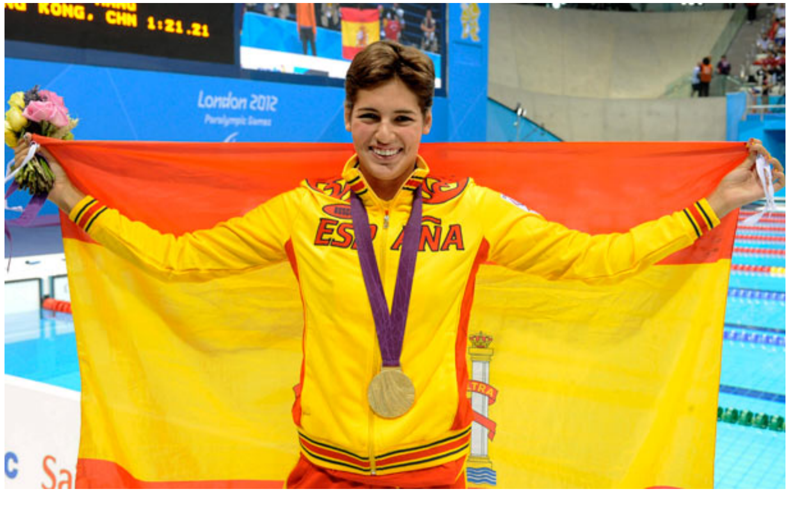
Pacing behavior, or how energy is used and distributed during exercise, is considered **crucial for optimal performance in competitive swimming**.

Considering the **low metabolic efficiency of swimming**, effective pacing strategy is a crucial component of swimming success.

The ability **to maintain swimming velocity throughout a race** is vital for optimizing performance across all swimming events.

McGibbon, Pyne, Shephard & Thompson (2018)

Michelle Alonso Morales competing in SB14 100 m final at the London Paralympic Games. | EFE



1. Introduction (2/4)

- Olympic swimmers had less stroke rate variability, longer stroke lengths and greater swimming speed stability than national level swimmers (Hellard et al., 2008).

- Variability in a swimmer's stroke length and stroke rate between or within laps, can cause an increased energy expenditure and negatively affect swimming performance (Escobar et al., 2018).

- Pacing behavior seems be related to cognition (Edwards & Polman, 2013; Elferink-Gemser & Hettinga, 2017; Van Biesen, et al., 2016), so the ability to effectively distribute energy during an exercise bout, may be impaired by II.

- Some of the intellectual factors to select an optimal pacing strategy include: considering previous experiences, knowledge of future physiological requirements, awareness of perceived exertion and deductive reasoning (Van Biesen et al., 2017).

1. Introduction (3/4)

Eligibility process in sports for athletes with intellectual impairment

Primary Check (INAS – IPC)

- **IQ ≤ 75**
- **Limitations in adaptative behavior**
- **Diagnosis Under 18 years**

IPC (2018)

Generic Sport Cognition Test Battery

Observation in competition

Competition race analysis

1. Introduction (4/4)

- **Pacing research in swimming, however, is limited** given, in part, the inability to externally control swimming pace effectively and difficulty in obtaining physiological measurements in the pool. Instead, plotting split times or stroke kinematics over each lap of the event are used (McGibbon, et al., 2018).

- **Pacing behavior may be one of the sport-specific skills** that is directly influenced by the presence of II (Van Biesen., Hettinga, McCulloch & Vanlandewijck (2017)

- Studies in elite runners with intellectual impairment demonstrated **the inability to self-regulate their running pace** when they need to rely on internal information (Van Biesen et al.,2017).

- However, pacing strategy is one of the **swimming skills that has not been adequately assessed amongst swimmers with intellectual impairment (II)** .

2. Aim

To assess the variability in pacing strategies along race performance of S14 class Paralympic swimmers Paralympic Games

International Paralympic Committee

2. Methods

Participants and variables

32 Paralympic swimmers (males=16, females=16) with II participating in the S14 class events during the **100m-breaststroke and 200m-freestyle** events at the **2012 London Paralympic Games**

The race performance of the swimmers were captured by a 25 Hz video camera and were analyzed using two-dimensional Direct Linear Transformation through the **individual-distance method.**

Veiga, Cala, Mallo & Navarro (2013)

Intra-individual variability in stroke rate (SR), stroke length (SL), stroke velocity (SV) and stroke index (SI) were determined for each lap

Statistical Analysis

A **linear mixed-model** with the lap as a fixed factor and the swimmer as the random factor was used to calculate the intra-swimmer (between laps) differences. **Standardized differences** were used to determine if the magnitudes of differences were trivial, small, moderate, large or extra-large. Significance was set at $p \leq 0.05$.

3. Results (1/6)

Descriptive variables between laps for males and females in the S14 200m freestyle

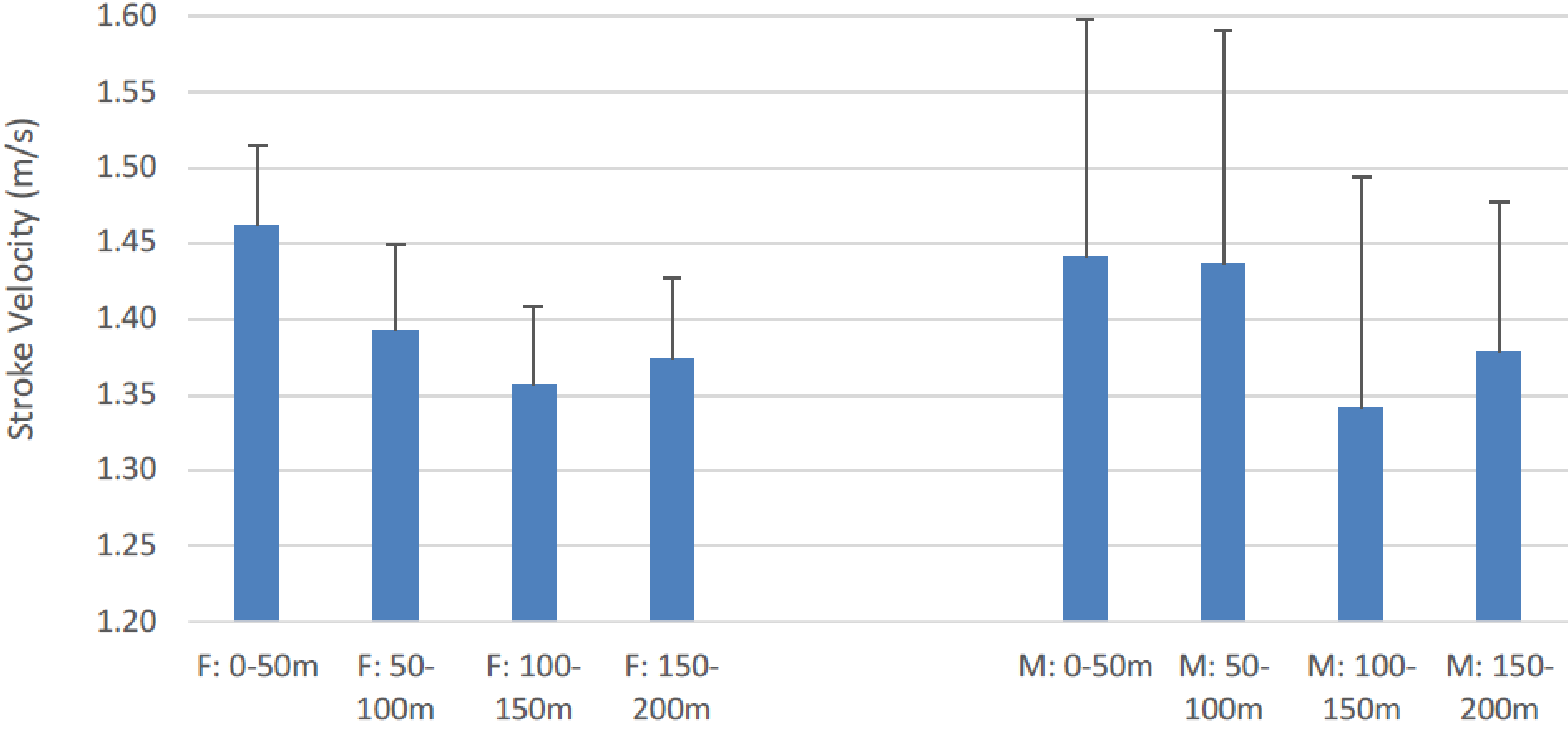
	Lap of Race			
	0-50m	50-100m	100-150m	150-200m
Females				
Stroke Length (m)	1.92±0.15	1.91±0.18	1.87±0.16	1.84±0.14
Stroke Rate (strokes/minute)	45.65±1.09	43.09±1.09	43.03±1.07	44.68±1.05
Stroke Velocity (m/s)	1.46±0.05	1.39±0.06	1.36±0.05	1.37±0.05
Stroke Index (m^2/s)	1.41±0.23	1.33±0.24	1.27±0.24	1.27±0.21
Males				
Stroke Length (m)	1.82±0.30	1.89±0.34	1.74±0.31	1.76±0.20
Stroke Rate (strokes/minute)	47.66±1.11	46.64±1.11	46.71±1.23	47.11±1.09
Stroke Velocity (m/s)	1.44±0.16	1.44±0.16	1.34±0.15	1.38±0.10
Stroke Index (m^2/s)	1.33±0.25	1.37±0.25	1.18±0.25	1.22±0.22

3. Results (1/2)

Standardized Differences in Stroke Velocity in Females and Males in the S14 Class 200m Freestyle

		Standardized Difference	Lower Confidence Limit	Upper Confidence Limit
Females				
0-50m	50-100m	1.27	0.66	1.87
0-50m	100-150m	1.94	1.34	2.54
0-50m	**150-200m**	**1.61**	1.00	2.21
50-100m	100-150m	0.67	0.07	1.28
50-100m	150-200m	0.34	-0.26	0.94
100-150m	150-200m	-0.33	-0.94	0.27
Males				
0-50m	50-100m	0.03	-0.67	0.73
0-50m	100-150m	0.69	-0.01	1.39
0-50m	**150-200m**	**0.39**	-0.31	1.09
50-100m	100-150m	0.66	-0.04	1.36
50-100m	150-200m	0.36	-0.34	1.07
100-150m	150-200m	-0.30	-1.00	0.40

3. Results (1/2)



Average stroke velocity between laps for males and females in the S14 100m breaststroke

3. Results (1/2)

Descriptive variables between laps for males and females in the S14 100m breaststroke

Lap of Race	0-50m	50-100m
Females		
Stroke Length (m)	1.52±0.23	1.58±0.29
Stroke Rate (Strokes/minute)	39.97±1.13	44.39±1.15
Stroke Velocity (m/s)	1.31±0.20	1.26±0.20
Stroke Index (m^2/s)	1.89±0.52	1.51±0.48
Males		
Stroke Length (m)	1.46±0.20	1.54±0.21
Stroke Rate (Strokes/minute)	35.71±1.10	39.30±1.17
Stroke Velocity (m/s)	1.23±0.12	1.29±0.13
Stroke Index (m^2/s)	2.44±0.52	2.01±0.47

3. Results (1/2)

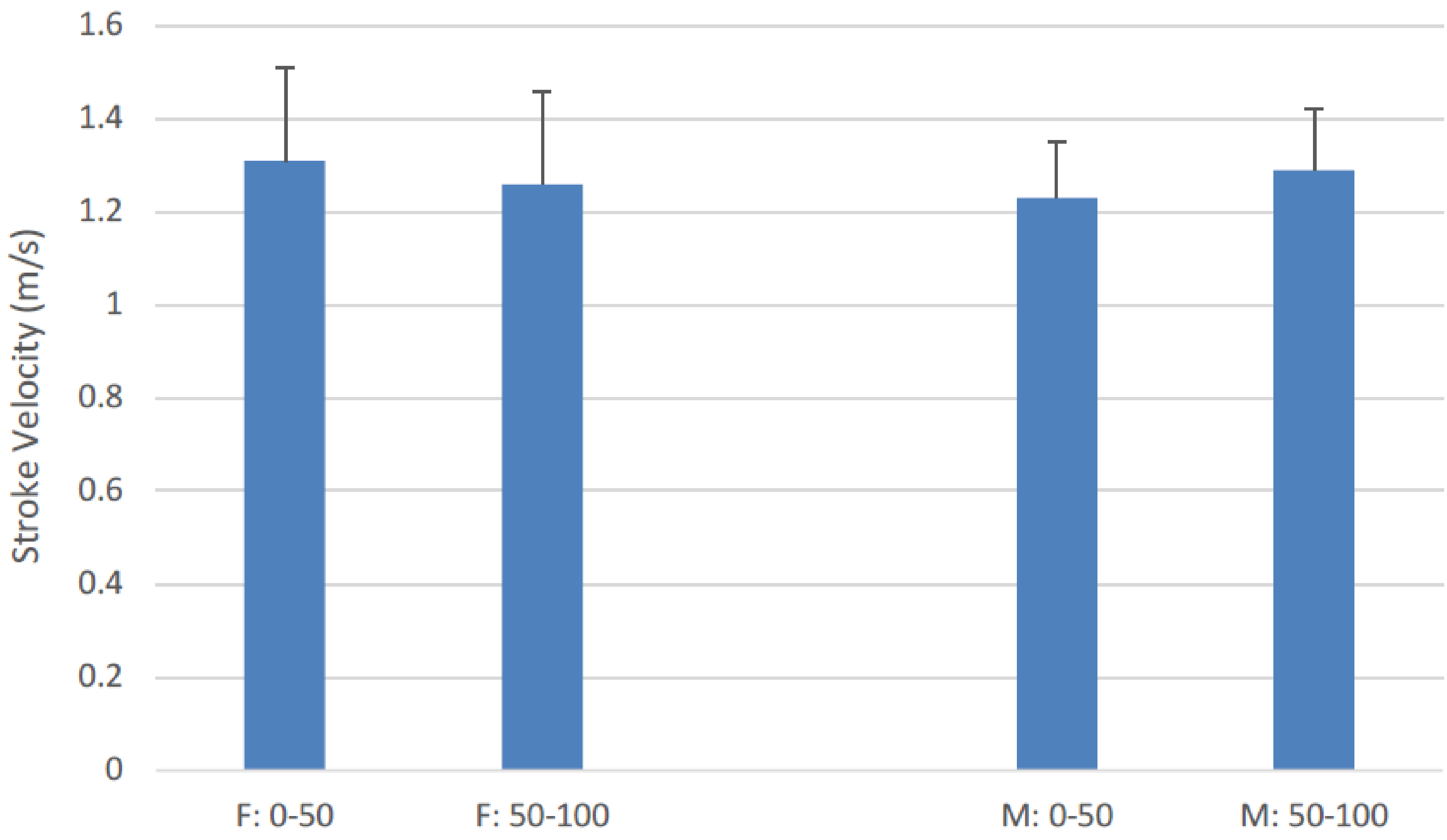
Standardized Differences in Stroke Velocity in Females and Males in the S14 Class 100m Breaststroke

		Standardized Difference	Lower Confidence Limit	Upper Confidence Limit
Women				
0-50m	50-100m	**-2.91**	-3.23	-2.59
Men				
0-50m	50-100m	**-1.83**	-2.26	-1.40

Standardized Differences in Stroke Index in Females and Males in the S14 Class 100m Breaststroke

	Lap of Race	Standardized Difference	Lower Confidence Limit	Upper Confidence Limit
Women				
0-50m	50-100m	**-1.68**	-1.93	-1.44
Men				
0-50m	50-100m	**-1.16**	-1.52	-0.80

3. Results (1/2)



Average stroke velocity between laps for males and females in the S14 100m breaststroke

4. Discussion

- For 200 freestyle, the small and moderate differences that were reported for stroke length and stroke rate, were similar to the differences that are commonly seen in able-bodied swimmers (Chollet, Pelayo, Tourny, & Sidney, 1996; Escobar et al., 2018).
- As previously observed by Chollet et al. (1996) and Escobar et al. (2017), decreases in stroke length occur due to fatigue, and stroke rate increases as a compensatory mechanism to maintain relative swimming speed.
- Variability in stroke rates and stroke length when compared to their able-bodied counterparts, this may indicate that they possess the skill necessary to maintain stroke length and stroke rate.
- However, the standardized differences that were observed for stroke velocity and stroke index were much different for swimmers with an II when compared to the differences seen in able-bodied swimmers (Dormehl & Osborough, 2015; Escobar et al., 2018; Huot-Marchand, Nesi, Sidney, Alberty, & Pelayo, 2005; McGibbon et al., 2018; Seifert, Boulesteix, Carter, & Chollet, 2005)

4. Discussion

- For 100 m breaststroke, both male and female swimmers with II had negative, moderate standardized differences in stroke length and stroke rate between L1 and L2, which indicates that stroke length and stroke rate increased moderately between laps.
- These results partially contradict the stroke length and stroke rate data that has been reported for able-bodied swimmers in breaststroke events (Thompson et al., 2010; Hellard et al., 2008) reported significant decreases in stroke length and significant increases in stroke rate during the breaststroke.
- The swimmers with II had very-large to extra-large differences in stroke velocity and moderate to large differences in stroke index. This contradicts the existing literature for able-bodied swimmers: Hellard et al. (2008) and Chollet et al. (1996) reported that able-bodied swimmers only had small differences in velocity between the two laps.
- Since extralarge and very-large differences in velocity occurred in females and males, respectively, the self-selected velocity may not have been appropriate.

5. Limitations and future directions

- Sample size and competitive level, not only Paralympic.
- Future studies should include the data from all heats rather than just the finals.
- The study focused on a sprint-distance synchronous stroke race and a middle-distance asynchronous stroke race. It would be beneficial to look at both sprint, mid, and long-distance events for synchronous and asynchronous strokes.
- Control group of AB swimmers as controls.
- Experimental designs to control variables, such as skill learning, coordination and fatigue should be performed in the future.

6. Conclusions

- Para swimmers with an II demonstrated significant variability in stroke velocity and stroke index in the 200m freestyle and stroke length, stroke velocity and stroke index in the 100m breaststroke events.

- Males II swimmers have more inter-swimmer variance in the 200m freestyle and females have more inter-swimmer variance in the 100m breaststroke. In both events, females showed much larger standardized differences between laps.

- Although differences were identified in variability in males and females, more research is necessary to better understand the mechanisms of the variance.

Thank you for your attention

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