Comparison of the fractal dimension among swimmers with different levels of expertise

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Introduction

Background: It is known that performance is strongly related to proportional changes in the inputs. The "marginal gains theory" in sports performance gained popularity a few years ago. It encompasses the assumption that small changes in the input (or the sum of several changes) may have a significant effect on the output.

Yet, it is unclear if nonlinear parameters such as fractal dimension (D) are able to distinguish subjects with different levels of expertise.

Aim: The aim was to compare the fractal dimension in swimmers with different levels of swimming expertise.

Methods

Sample: 3 groups of 25 swimmers (total 75):

- highly qualifies (international level)
- Experts (national level)
- Non-experts (non-competitive swimmers)

Protocol: randomly assigned 4 x 25m all-outs at:

- Front-crawl
- Backstroke
- Breaststroke
- Butterfly stroke

Data collection: Speedo-meter (Swim speedo-meter, Swimsportec, Hildesheim, Germany) [1] (Fig 1).

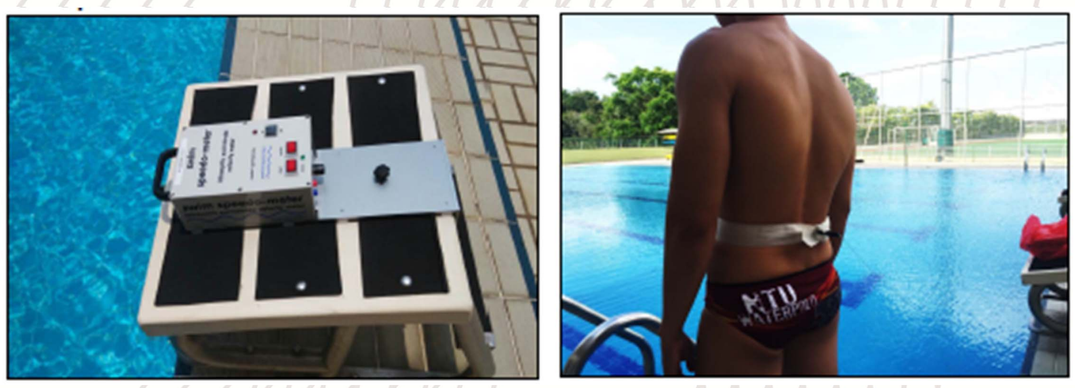

Fig. 1. The speedo-meter selected for data collection.

Data analysis: Computation of the fractal dimension (eq. 1) [2]:

$$D = \frac{d \log N(L(k))}{d \log(k)} \quad (1)$$

Statistical procedures: 2-ways repeated-measures ANOVAs (group x swim stroke; 3 levels of expertise x 4 swim strokes; $P \leq 0.05$)

Results

Speed: There was an expertise x swim stroke interaction ($F_{6,72}=3.564$; $P<0.001$; $\eta^2=0.13$) in the swim speed.

Front-crawl was the fastest stroke, followed by the Butterfly, Backstroke and Breaststroke ($P<0.001$).

D (expertise x stroke interaction): There was a non-significant expertise x stroke interaction.

D (swim stroke effect): A moderate effect of the swim stroke was noted.

Breaststroke showed the highest D followed by Butterfly, Front-crawl and Backstroke.

D (expertise effect): A small but significant effect of the expertise level was found.

Higher in non-experts than remaining groups.

There was a shift of the 95CI to the left side (i.e. a decrease of the FD) comparing non-experts with competitive counterparts.

	Fractal dimension (D, dimensionless)			
	Front-crawl Mean ± 1SD (95CI)	Backstroke Mean ± 1SD (95CI)	Breaststroke Mean ± 1SD (95CI)	Butterfly Mean ± 1SD (95CI)
Highly qualified	1.84±0.08 (1.80-1.87)	1.83±0.06 (1.79-1.85)	1.92±0.02 (1.90-1.93)	1.88±0.07 (1.85-1.91)
Experts	1.85±0.09 (1.81-1.88)	1.85±0.06 (1.82-1.87)	1.92±0.03 (1.90-1.93)	1.88±0.06 (1.84-1.90)
Non-experts	1.89±0.06 (1.86-1.91)	1.88±0.04 (1.86-1.90)	1.94±0.02 (1.92-1.95)	1.92±0.04 (1.90-1.94)

ANOVA				
	DoF	F	P	η^2
Expertise x stroke interaction	6,72	1.661	0.13	0.03
Expertise level effect	2,72	5.070	0.01	0.12
Swim stroke effect	3,72	51.689	<0.001	0.41

Conclusions

The D is prone to decrease with increasing expertise. Hence, the complexity level of the motor behaviour in swimming is dependent on the swimmer's expertise.

References

[1] Barbosa, T.M., et al (2010a). *Scandinavian Journal of Medicine and Science in Sports,* 25, 184-196.

[2] Higuchi, T. (1988). *Physica*, 31, 277-83.