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Full Length Article

Behavioural variability and motor performance: Effect of practice specialization in front crawl swimming

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ABSTRACT

The aim was to examine behavioural variability within and between individuals, especially in a swimming task, to explore how swimmers with various specialty (competitive short distance swimming vs. triathlon) adapt to repetitive events of sub-maximal intensity, controlled in speed but of various distances. Five swimmers and five triathletes randomly performed three variants (with steps of 200, 300 and 400 m distances) of a front crawl incremental step test until exhaustion. Multi-camera system was used to collect and analyse eight kinematical and swimming efficiency parameters. Analysis of variance showed significant differences between swimmers and triathletes, with significant individual effect. Cluster analysis put these parameters together to investigate whether each individual used the same pattern(s) and one or several patterns to achieve the task goal. Results exhibited ten patterns for the whole population, with only two behavioural patterns shared between swimmers and triathletes. Swimmers tended to use higher hand velocity and index of coordination than triathletes. Mono-stability occurred in swimmers whatever the task constraint showing high stability, while triathletes revealed bi-stability because they switched to another pattern at mid-distance of the task. Finally, our analysis helped to explain and understand effect of specialty and more broadly individual adaptation to task constraint.

1. Introduction

In competitive swimming, a delicate balance between movement pattern stability and flexibility is required too achieve and maintain a high speed. Indeed, although swimmers need to attain consistent swimming speed they also need to be able to successfully adapt their movements to changes in the performance environment and task (e.g., turn, wave drag caused by other swimmers, fatigue) (Seifert et al., 2014). To achieve these aims, the ecological dynamics framework advocates that there is an intertwined relationship between perceptions and actions of each individual to adapt to a set of constraints in

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interaction (Davids, Araújo, Hristovski, Passos, & Chow, 2012; Davids, Araújo, Seifert, & Orth, 2015; Seifert, Button, & Davids, 2013). In fact, traditionally, a high-level of expertise in sport has been associated with the capacity to reproduce a specific movement pattern consistently and to reduce attention demands during performance by increasing the automaticity of movement (Abernethy, Poolton, Masters, & Patil, 2008). From that viewpoint, expertise in sport was associated with a reduction in deviations in task performance from an ideal expert standard, meaning that movement variability was considered as noise in performance (Newell, Deutsch, Sosnoff, & Mayer-Kress, 2006; Newell & Slifkin, 1998; Slifkin & Newell, 1998). However, research within the ecological dynamics framework has shown that movement and coordination system variability should not necessarily be understood as noise, error, or a deviation from a putative expert model, which is detrimental to performance (Davids, Glazier, Araújo, & Bartlett, 2003; Glazier & Davids, 2009; Seifert et al., 2013). A key idea is that movement and coordination pattern variability can be viewed as a functional property to help performers to adapt their behaviours to task-goal. More precisely, functional behaviours emerge during practice from the interaction of constraints on each individual (task, environmental and organismic) (Newell, 1986; Seifert, Button, & Brazier, 2011), leading to intra- and inter-individual movement and coordination pattern variability and suggesting that there is no ideal motor solution that all swimmers should imitate.

This functional intra- and inter-individual movement and coordination pattern variability was emphasized both in novice breaststrokers for a given speed (Seifert, Leblanc, et al., 2011) and in expert breaststrokers when they adapt their behaviour to different swimming speeds (Komar, Chow, Chollet, & Seifert, 2015). Similarly, swimming at high intensity (Figuereido, Seifert, Vilas-Boas, & Fernandes, 2012) and at several swimming speeds (Bideault, Hérault, & Seifert, 2013) in front crawl led to individual adaptation that could be linked to swimmer's specialty. For instance, it has been shown that long distance swimmers and triathletes exhibited lower range of coordination repertoire that may be due to their lower range of swimming speeds during training and race (Millet, Chollet, Chalies, & Chatard, 2002; Seifert et al., 2010). In sum, there is no rule to look for stability or flexibility, because movement and coordination variability could be functional when it leads to efficient outcomes or at least to similar performance. Thus, behavioural adaptability must be considered as a subtle blend between stability and flexibility, resulting in on-going motor organization to adapt to constraint in order to reach the task-goal. From there, the aim of this current study was to examine how swimmers with various specialty (competitive short distance swimming vs. triathlon) adapt to repetitive events of sub-maximal intensity, controlled in speed but of various distances (six to seven bouts of 200, 300 and 400 m). Indeed, while the intensity remains constant, the distance (and consequently the time) during which this intensity is performed changed, which could lead to behavioural adaptation due to various cycles' repetition. Thus, changes in behavioural patterns (i.e., mono-stability vs. multi-stability) was examined in order to determine the presence of behavioural variability within and between individuals. It was hypothesised that when task constraints is fixed and controlled, competitive swimmers may reveal lower behavioural variability (both within and between individual) than triathletes who have less habit of being constrained (e.g., by speed pacing, by swimming at various speed, etc) because these latter mainly compete for an advantaged position in the leading pack rather than for the best time.

2. Methods

2.1. Population

A group of ten participants, divided in two groups, voluntary participated in this study. The first group was composed by five male triathletes with mean age: 23.4 ± 8.2 yr; mean height: 179.4 ± 4.4 cm; mean weight: 70.3 ± 4.8 kg; mean arm span: 184.3 ± 5.3 cm. At the time of the experiment, they competed at national level and were training 12.4 ± 2.3 h per week and had 10.0 ± 2.3 years of practice. The second group was composed by five male swimmers with mean age: 20.8 ± 3.2 yr; mean height: 182.3 ± 5.6 cm; mean weight: 74.7 ± 4.2 kg; mean arm span: 188.4 ± 4.6 cm. At the time of the experiment, they were training 18.7 ± 1.4 h per week and had 13.2 ± 2.5 years of practice. Swimmers were specialist of 200 and 400 m freestyle, and their best performance for these race distances corresponds to a national level and is 90.6 ± 2.8% of the 2011 world speed record. Procedures described below were accepted by the Institutional Ethics Committee and followed the Helsinki Declaration on human experiments. Participants were told about the study procedures and experiments and filled in a written informed consent previously approved by the Institutional Ethics Committee.

2.2. Protocol

In a 25 m indoor swimming pool (1.90 m deep and water temperature at 27.5 °C), and after a 1000 m moderate intensity warm-up, participants randomly performed three variants (with steps of 200, 300 and 400 m distances) of a front crawl incremental step test until exhaustion (with a 48 h rest period in-between) (Fernandes, Sousa, Machado, & Vilas-Boas, 2011). Participants swam with arms and legs, used in water starts and flip turns, and the pace of each step (common to the three variants) was controlled through a visual pacer with flashing lights on the bottom of the pool (TAR. 1.1, GBK-electronics, Aveiro, Portugal). The pace required for the last step was predefined against the swimmers current personal 400 m front crawl best time and $0.05\ m\cdot s^{-1}$ was successively subtracted allowing the determination of the mean target speed for each step of the incremental test (Fernandes et al., 2008). This allowed each participant to maintain an even pace in each step, to swim faster for each successive trial and also to accomplish the same step speed in each of the three step