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Assessment of an International Breaststroke Swimmer Using a Race Readiness Test

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Competitive swimmers routinely undertake a 7 × 200-m incremental step test to evaluate their fitness and readiness to compete.[1] An exercise protocol more closely replicating competition swimming speeds may provide further insight into the swimmer's physiological and technical readiness for competition. This case study reports data over a 3-year period from 11 Race Readiness Tests, which were completed, in addition to the 7 × 200-m test, as an attempt to provide the swimmer and coach with a fuller assessment. For this individual, data provided objective information from which to assess training status and race readiness following a transition from 200-m to 100-m race training. Data also raised a question as to whether a 100-m maximal effort 10 minutes before another one actually enhances performance owing to a priming effect.

Method

A male international breaststroke swimmer (personal best in the 100-m long course of 60.64 seconds, age 26 years, height 1.80 m, and body mass 76.0 kg) completed a standardized 1,200-m warm-up in a 25-m pool followed by the Race Readiness Test (RRT, see Table 1) on 11 occasions over a 3-y period. The RRT was undertaken 48 hours after a 7 × 200-m step test.[1] Four RRT (2, 4, 6, 9) were undertaken within 2 weeks of 100-m competition performances conducted in a 50-m pool (see Figure 1).

Results and Practical Applications

Spearman rank order correlations demonstrated significant relationships between repetition speed and mean turning times for the first 100-m ($\rho = -0.61$, $P = .05$) and second 100-m ($\rho = -0.66$, $P = .03$) repetitions of the RRT. These data indicate that turning times tended to improve when swimming speed improved and are in agreement with previous research,[2] although this is the first longitudinal study to

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Table 1 Race Readiness Test (RRT)

Race Readiness Test Protocol
1,200-m Warm-up
400-m swim freestyle/backstroke, 200-m drills breaststroke, 200-m freestyle, 8 × 50-m breaststroke alternating fast and easy 25-m efforts.
Then 10 minutes of passive recovery followed by these repetitions:
Rep 1: Maximal effort 50-m from dive start, and then 7 minutes of seated passive recovery.
Rep 2: Maximal effort 100-m from dive start, and then 10 minutes of seated passive recovery.
Rep 3: Maximal effort 100-m from dive start, and then seated passive recovery until measurements complete.
Temporal measurements during repetitions
1. Start time to 15 m.
2. Turning Times—from 7.5 m in to 7.5 m out.
3. Split times every 50 m.
Perceptual and physiological measurements for repetitions
4. RPE 6–20 scale[5] and heart rate (Polar Electro Oy, Finland): measured at rest, 9 minutes after the completion of the warm-up and within 5 seconds after exercise.
5. Capillary (ear lobe) whole blood lactate concentration (5 µL-Lactate Pro, Ackray, Japan): measured at rest, 9 minutes after the completion of the warm-up and within 45 seconds, 3, 6, 9, 12, and 15 minutes postexercise. For the 50-m repetition and the first 100-m repetition, measurements ceased at 6 minutes and 9 minutes respectively.

observe this. Tests RRT2, RRT6, and RRT9 (Figure 1) demonstrated faster test times and increased post-100-m repetition blood lactate concentrations [La^-] compared with their preceding tests, which is consistent with an increasing emphasis on anaerobic training during race-specific preparation. In addition, only a 0.5% difference was observed between their three fastest 100-m repetition times, and, notably, competition performances soon after were within 0.7% of one another. In RRT4, the fastest 100-m repetition time was 1.5% to 1.7% slower by comparison and coincided with a reduced race speed (1.1% to 1.6%) during the subsequent competition. These findings provide some support to the validity of the test to determine race readiness.

Across tests, there was a trend toward a greater peak [La^-] with increasing repetition speed for the first 100-m effort ($\rho = 0.60$, $P = .05$), which may suggest that development of an increased buffering capacity and/or anaerobic energy metabolism relates to 100-m performance. Interestingly, this relationship was not observed for the second 100-m repetition, which may have been due to a carry-over or priming effect. Peak blood lactate, heart rate, and RPE values were greater following the second 100 m compared with the first 100-m and were, respectively, 15.3 ± 1.0 vs. 12.8 ± 1.4 m*M*, $t = -9.2$, $P = .01$; 180 ± 6 vs. 172 ± 4 $b \cdot min^{-1}$, $t = 2.82$, $P = .03$; and 20 ± 0 vs. 18 ± 2, $Z = 2.83$, $P = .01$. This would suggest that the second 100 m required a greater energy expenditure and effort level, which might reflect reduced economy or greater fatigue due to a carry-over effect, but could also indicate that the first 100-m repetition "primed" the second 100 m. There has been recent speculation that prior heavy exercise might speed the onset of $\dot{V}O_2$ kinetics and/or elevate the primary amplitude and that an elevated lactate concentration may vasodilate exercised muscle beds and enhance the Bohr shift for the

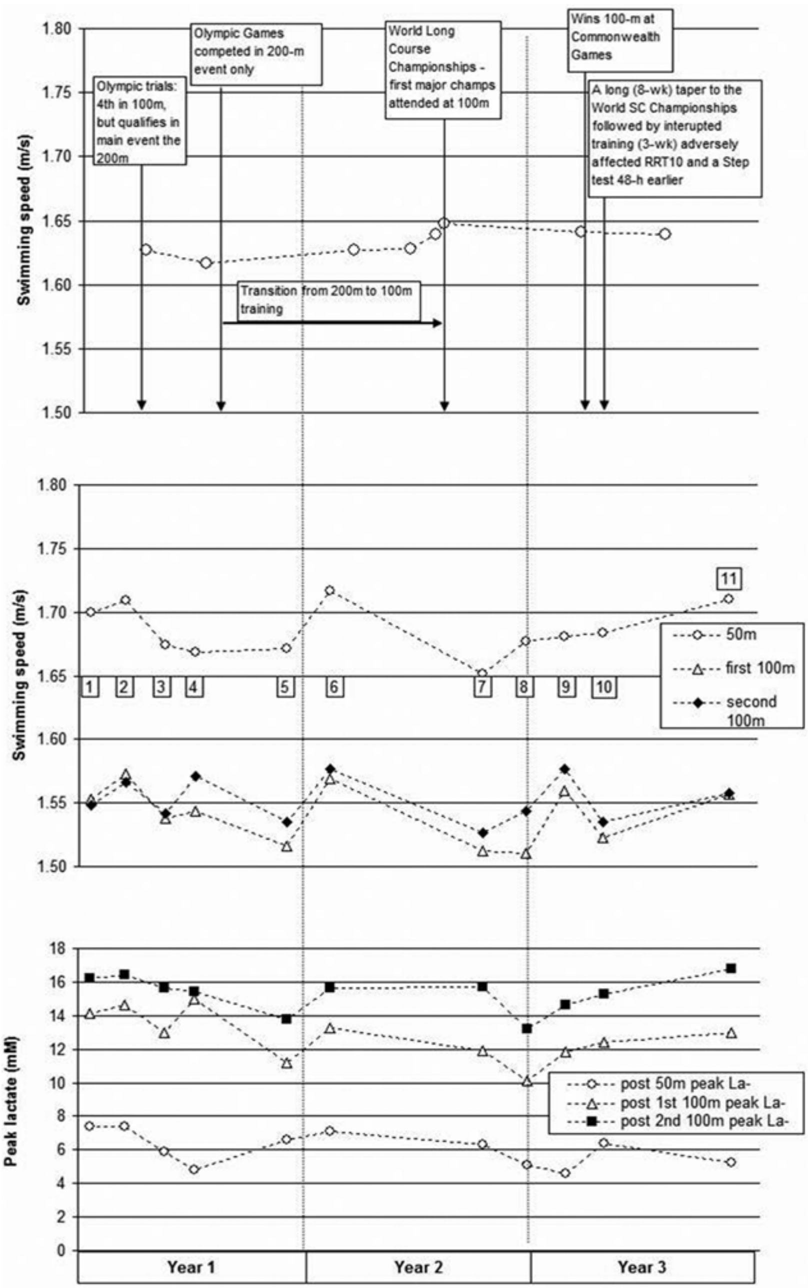

Figure 1 — Upper panel: 100-m breaststroke competition speeds. Middle panel: RRT 50-m, first 100-m, and second 100-m repetition speeds. Lower panel: RRT peak lactate concentrations.

second exercise bout.[3] The RRT data also demonstrate a nonsignificant trend toward faster finishing times in the second 100 m compared with the first 100-m repetition (64.42 ± 0.74 vs. 64.90 ± 0.97 s, $t = 2.99$, $P = .13$). These data raise a question as to whether a maximal 100-m swim 10 minutes before another one may enhance performance on the second 100 m, which has implications for training set design and pre-race preparation and warrants further investigation.

It must be acknowledged, however, that the mean difference between 100-m repetition times within each RRT was only ~0.8 s or ~1.2% for 9 out of 11 tests, which is within the performance variability that has been observed in competition swimming (1.2 to 1.5%).[4] Therefore, it could be argued that the second 100-m repetition of the RRT protocol is unnecessary; however, as the data show that a maximal performance is possible after 10 minutes of recovery for this elite swimmer, the second repetition does confirm that a maximal performance has occurred (or not). For example, in RRT4 an unusual variation of 1.8% was detected between the first and second 100-m repetition times and the swimmer admitted consciously pacing the first 100-m repetition owing to uncertainty regarding his fitness following a period of disrupted training, which had adversely affected RRT3. The prescription of two 100-m repetitions resulted in a true performance on the second repetition and highlighted a confidence issue that the support team members were able to address before the Olympic Games.

The training leading up to each of the bouts of testing was markedly different, and in our view the RRT data when combined with the step test data provided a good understanding of the swimmer's training adaptations and race readiness. For example, before RRT2 and RRT6, consistent 200-m and 100-m training were completed respectively. Step test data immediately before RRT6 demonstrated a 0.06 to 0.11 $m \cdot s^{-1}$ reduction in swimming speeds, eliciting blood lactate concentrations of 2 m*M* to 8 m*M* (s-2m*M* to s-8m*M*) compared with data immediately before RRT2. Using step test data only, we would not have determined, a few weeks before competition, that the swimmer's race readiness was actually similar on both occasions. Temporal data from RRT6 provided part of the explanation as it was found that start and turning times were improved compared with RRT2 (start times by 0.4 to 0.5 second and turning times by ~0.3 second per turn) and so technical improvements had offset some of the deterioration in aerobic fitness. Between RRT6 and RRT 9, the s-2 to s-8 m*M* concentrations improved to within 0.01 to 0.03 $m \cdot s^{-1}$ of those before RRT2 through an increased aerobic training load, while an attempt was made to maintain perceived improvements in anaerobic capacity (see 100-m personal best time on Figure 1) through quality 100-m training sets. The rationale was that the anaerobic capacity is finite or cannot be improved to the same extent as the aerobic capacity. The RRT data showed that although start and turning times were lower for RRT9 than for RRT2, they had slowed compared with RRT6, which may have been due to the change in training emphasis. Consequently, despite differences in metabolic and technical aspects, similar 100-m times were achieved for RRT2, RRT6, and RRT9, and in competition soon afterward. The combination of Step test and RRT data provided an appreciation of the complexity of these performances.

Before RRT5, the swimmer suffered an 8-week period of disrupted training (as a result of injury and an upper respiratory infection), which led to a 3.1% drop in 100-m repetition performance compared with RRT6. The step test before RRT5 demonstrated that the swimmer's aerobic fitness was markedly affected with relatively low speed lactate and heart rate values measured.

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