FEEDBACK ON ROWERS' MECHANICAL POWER OUTPUT IMPROVES COMPLIANCE TO INTENDED ON-WATER TRAINING INTENSITY

Lotte L. Lintmeijer[1], Mathijs J. Hofmijster[1,2], Freek S. Robbers[1], A.J. "Knoek" van Soest[1], Peter J. Beek[1]

[1]Vrije Universiteit Amsterdam, Amsterdam, The Netherlands
[2]Amsterdam University of Applied Sciences, Amsterdam, The Netherlands
Corresponding author email: l.l.lintmeijer@vu.nl

In rowing, mechanical power output (MPO) is a defining characteristic of training intensity and may be used to control on-water training intensity. However, rowers' behavioural response to real-time feedback on MPO need to be examined first. The aim of this study was to test whether rowers are able to comply with MPO targets when they receive real-time feedback on MPO. Eighteen rowers performed training sessions in which they rowed at different intensities while receiving traditional feedback or additional real-time feedback on MPO. Rowers reduced the difference between target MPO and delivered MPO during all intensity intervals, while between-strokes fluctuations in MPO were only diminished during the medium-high intensity intervals when real-time feedback on MPO was provided. We conclude that rowers adjust their behaviour based on real-time feedback on MPO. Therefore, it has the potential to improve control of training intensity in on-water rowing.

KEY WORDS: rowing performance, real-time feedback, mechanical power output

INTRODUCTION: Rowing performance is defined as the average shell velocity over 2000 meter. In order to maximize average velocity rowers need to optimize their aerobic and anaerobic physical capacities. To achieve this, training sessions at different intensities are of great importance. The most straightforward parameter to control training intensity would be the metabolic energy consumption of a rower (i.e. Mäestu, Jürimäe, & Jürimäe, 2005). However, since it is practically impossible to measure this quantity during every training, athletes and coaches adopt different parameters that reflect this metabolic effort, such as boat velocity, stroke rate, rowers' subjective feeling and heart rate (Smith, 2011). The problem with these parameters is that they are affected by external factors such as weather conditions and the state of the rower. Mechanical power output (MPO) delivered by the rower is not affected by these external factors and is strongly related to metabolic effort (Hofmijster, van Soest, & de Koning, 2009). On that ground it forms an interesting alternative to the aforementioned parameters.

Recent technological developments allow for a valid calculation of a rower's MPO (Lintmeijer, Hofmijster, Schulte Fischedick, Zijlstra, & van Soest, submitted) and for real-time feedback of this quantity while rowing. In order to use MPO as a feedback parameter to control training intensity, it is important to determine if rowers are capable to adjust their training intensity based on feedback on MPO. Although in cycling training on MPO is already common practice, it is not trivial that rowers will be able to adjust their MPO based on feedback on MPO during on-water training sessions. Indeed, rowing technique and the interaction with other rowers in the boat may influence a rower's MPO as well. Therefore, research is required in which the behavioral response to feedback on MPO during training sessions with different training intensities is tested.

The primary aim of this study was to examine whether rowers are able to adjust their MPO based on real-time feedback on MPO. More specifically, it was tested whether availability of additional real-time feedback on MPO improves the compliance of rowers to MPO targets, in comparison to a situation where they had traditional feedback such as boat velocity, stroke rate, subjective feeling and heart rate. Subsequently, it was examined whether rowers showed less between-strokes fluctuations in delivered MPO when they were provided with real-time feedback on MPO compared to traditional feedback.

METHODS: Eighteen Dutch rowers, with a minimum of 2.5 years experience in intensive rowing, rowed 3 identical training sessions in crewed boats. In all training sessions the rowers were instructed to row at low and medium-high intensities. Related target power outputs, based on previously determined ergometer scores, were given before the first training session. In the first two sessions the rowers were provided with traditional feedback on training intensity (subjective feeling, stroke rate, and/or heart rate), while during the third session they got additional real-time feedback on their delivered MPO. Training sessions were adjusted to the rowers' normal training sessions and consisted of at least a warming up, 3 times 2000 meter of low intensity rowing and a 1500 meter of medium-high intensity rowing.
Horizontal-plane oar angle and forces at the oar pin were measured (Peach Innovations Ltd., Cambridge, United Kingdom; 100Hz). MPO per complete stroke cycle was calculated using the algorithm described in Lintmeijer et al. (submitted) and provided to the rowers using a custom made android application that was running on Samsung S5 smart phones.
Data were processed using Matlab 2015b. To determine the effect of additional real-time feedback on compliance to target MPO, the absolute difference between target MPO and delivered MPO was calculated per stroke cycle and averaged for every intensity interval. In order to examine the effect of real-time feedback on between-strokes fluctuations in delivered MPO, standard deviations of delivered MPO per intensity interval were calculated. Stroke start was defined as the instant at which the sum of the two oar angular signals changed sign from negative to positive.
Multilevel analyses were conducted using SPSS 21. For every intensity interval, at least 80 steady-state strokes were selected (based the acceleration pattern of the boat and oar angle patterns or the rowers).

RESULTS: Preliminary multi-level analyses suggest that the absolute difference between delivered MPO and target MPO per stroke cycle was smaller when rowers were provided with additional real-time feedback on MPO compared to traditional feedback only ($F(186.36)=37.83$, $p<.001$) (see figure 1). The standard deviations of delivered MPO in the low intensity rowing intervals did not change when rowers were provided with additional real-time feedback on MPO, while it decreased during the medium-high intensity intervals ($F(186.07)=2.28$, $p=.013$) (see figure 2). This suggests that rowers MPO fluctuated less during high-medium intensity intervals when rowers received additional real-time feedback on MPO compared to traditional feedback only.

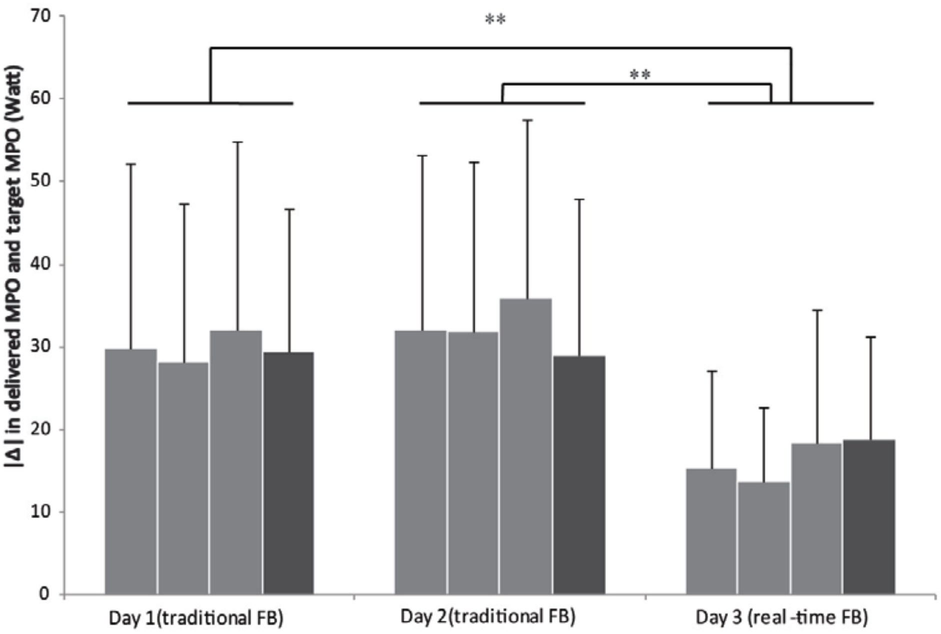

Figure 1: The average absolute difference (|∆|) between delivered MPO and target MPO per low (light grey) and medium-high intensity (dark grey) intervals per day. Error bars illustrate 1 SD of the |∆| between delivered MPO and target MPO per intensity interval. ** means p<.001.

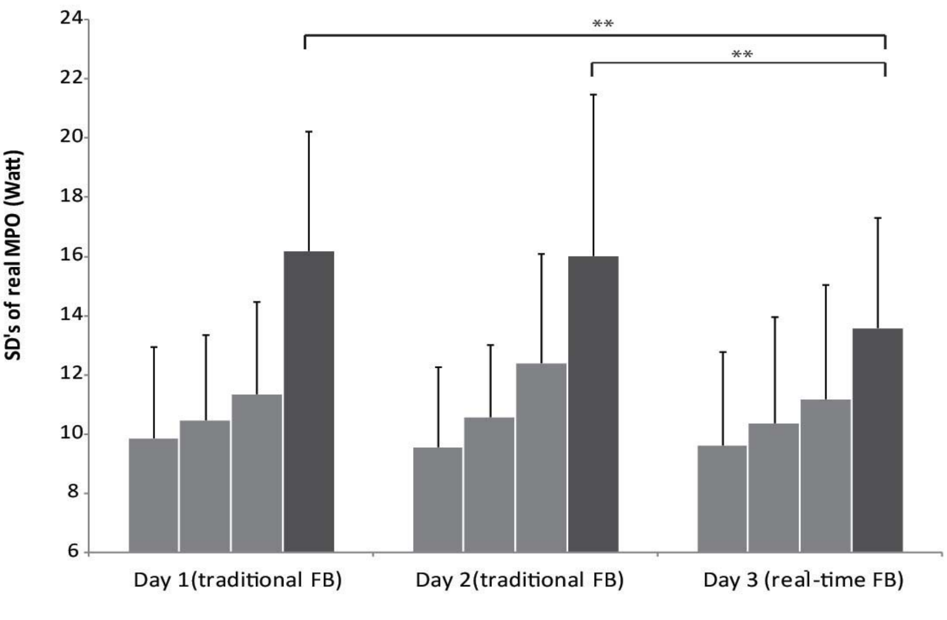

Figure 2: Average standard deviations (SD's) of delivered MPO per low (light grey) and medium-high intensity (dark grey) intervals per day. Error bars illustrate one SD of the SD's of delivered MPO per intensity interval. ** means p<.001.

DISCUSSION: These results indicate that rowers better complied with MPO targets when they were provided with real-feedback on MPO. This implies that rowers are able to adjust rowing intensity in the direction of the imposed targets, based on real-time feedback on MPO. In addition, rowers showed less between-strokes fluctuations in delivered MPO during medium-high intensity intervals when they were provided with additional feedback on MPO compared to traditional feedback only. However, for the low intensity intervals between-strokes fluctuations on MPO were not affected by additional real-time feedback on MPO. This might have been due to a 'floor' effect of the between-strokes fluctuations in the low intensity intervals.
More detailed analyses are warranted in order to gain a better understanding of rowers' behavioral changes in response to availability of real-time feedback.

CONCLUSION:
The results of this study suggest that skilled rowers are able to adjust their behavior -and thus their training intensity- based on real-time feedback on MPO. This information is highly relevant to researches, rowers and coaches who would like to control on-water training intensity, since it highlights the possibilities of using MPO as a parameter to control and monitor training intensity on a daily basis.

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