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CONCURRENT VERSUS DELAYED FEEDBACK: BIOMECHANICS IN ROWING

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Biomechanical characteristics of rowers are often compared with ‘gold standard’ characteristics in order to identify improvable aspects of technique and to facilitate technique improvements. Biomechanical characteristics of athletes from the Canadian Women’s Under 23 Rowing team (n=8) were evaluated and two different methods of feedback were trialed to assess their effectiveness. Results showed 1 of 6 biomechanical characteristics to change significantly (p <.05) between trials. However, since boat speed (m/s) increased by 18.2% when using concurrent augmented feedback instead of a combination of visual and verbal delayed feedback, concurrent feedback was adopted by the team. Literature suggests this method would require alteration to be successful in different sports and concurrent feedback should be supplemented by delayed feedback in order for long term skill retention to occur.

KEYWORDS: case study, applied, performance, coaching.

INTRODUCTION:

For some time, international rowing teams have been measuring the biomechanical characteristics of rowers during training in an attempt to provide athletes with constructive feedback. The aim of such feedback is to facilitate positive technical change that impacts on boat speed and helps win races. Research by Baudouin and Hawkins (2004) and Kleshnev (2004) and has shown that important biomechanical characteristics which impact on boat speed include; angle of the oar when it enters the water during each stroke (^{o}) (known as ‘catch angle’), angle of the oar when it exits the water (^{o}) (known as ‘finish angle’), angle covered between ‘catch’ and ‘finish’ angles (^{o}) (known as ‘arc length’), the amount of degrees from the ‘catch’ at which maximum force (N) and 70% of maximum force (N) is applied, and Power (W).

For each of these variables, it has also been shown by Kleshnev (2001) that there are optimal results for athletes of different groups (gender, weight, sweeping and sculling). Hill (2002) also found that, between athletes in the same boat, increased synchronicity of these characteristics produced increased boat speeds.

Since providing technique feedback to athletes is a source of augmented (external) feedback designed to improve the learning experience of the athletes, the method used to feedback the information should be considered since some methods are known to be more effective than others. For example, some individuals learn more effectively to visual stimuli and some to auditory (Walling, 2006). Wulf & Schmidt (1997) also suggested that practicing a skill with concurrent visual feedback is less effective for learning than practicing with feedback provided following the movement. Since optimization of the method used to feedback biomechanical information had not been considered with the athlete group previously, a significant improvement in all biomechanical characteristics was hypothesized when using the optimized method.

The present investigation aims to identify an improved method of providing biomechanical information by evaluating the change in biomechanical characteristics of athletes, when different feedback mechanisms were used. Findings will help shape the information feedback strategy when working with Canada’s future Olympic rowers and could impact on their level of success.

METHOD:

During June 2011, a case study was performed with the Canadian women’s under 23 (U23) team where the effectiveness of two different methods used to feedback biomechanical information was assessed. Both methods involved comparison of results produced with data from existing literature and using augmented feedback to encourage rowing technique change. The athletes in the team (n=8) were all from the same ‘women’s eight’ boat. Prior to the testing, the coach and each athlete verbally agreed to the experimental protocol, and when joining the Canadian team, each athlete provided written informed consent for forthcoming testing.

During Trial 1, biomechanical data was collected during a ‘race simulation piece’ integrated into the rowers training session using ‘Peach Powerline Rowing Instrumentation’ (Peach Innovations Ltd, Cambridge, UK) and its accompanying software used to display data and automate identification of variables such as ‘Arc Length’ and ‘Catch Angle’. Data for oar angle and force was recorded at 50Hz, enabling each biomechanical variable to be reported for each rowing stroke. Data for each stroke was averaged for each variable over 200m of rowing. Water current and wind speed were negligible. The data acquired was downloaded and analyzed by comparing it to previous research into optimal biomechanical characteristics shown in Table 1.

Table 1
Optimal biomechanical characteristics for rowers in a women’s eight boat (Kleshnev, 2011).

Arc Length (^{o})	Catch Angle (^{o})	Finish Angle (^{o})	Degrees to max Force (^{o})	Degrees to 70% of max Force (^{o})
90.0	-58.0	-34.0	29.2	13.0

Each athletes data was compared to this benchmark and any discrepancies observed. After a delay of approximately three hours, the data from Trial 1 was delivered to the athletes by the coach and the biomechanist using a combination of verbal and visual delayed feedback. This method of feedback was the coaches’ preference whereby technique points for future focus were provided.

With the feedback from Trial 1 considered, the athletes completed Trial 2 approximately 2 hours later in attempt to improve their biomechanical characteristics. Trial 2 involved the same training as for Trial 1. Trial 3 involved a different method of information feedback in an attempt to improve the athletes learning experience and their technique. Since Schmidt & Vrisberg (2008) suggested that skill acquisition in various skill based sports was improved by concurrent auditory feedback, a method of providing concurrent auditory feedback was established.

To test this feedback mechanism, technology that had not previously been used by the Canadian women’s rowing team was piloted in Trial 3. An ‘add on’ to the ‘Peach Powerline Rowing Instrumentation’ enabled data collected to be concurrently transmitted from the rowing boat to a computer located in the coaches boat. The data was viewed concurrently and the coach was able to verbally identify better and worse strokes for individuals as they occurred in comparison to optimal biomechanical characteristics. As for Trial 1, data from Trials 2 and 3 was taken from high intensity rowing at high stroke rate in a straight line, with no current or wind.

All data reported is shown with standard deviation. A one-way repeated measured ANOVA was used to measure differences between trials for each biomechanical characteristic and Bonferroni corrections were used to help assess differences between groups. Statistical significance was set to $p = 0.05$.

RESULTS:

Data collected during Trials 1, 2 and 3 is shown in Table 2. The only variable to show a significant change was catch angle where $F (1.077, 7.536) = 16.759$. Pairwise comparisons showed significant changes between both Trial 1 and 2 (0.035) and Trial 2 and 3 (0.006). A main effect was seen for ‘catch angle’, with differences seen between all 3 trials. Boat speed appears to increase by 18.2% between trials 2 and 3

Table 2
Comparison of biomechanical characteristics between Trials 1, 2 and 3.

Trial	Arc Length (°)	Catch Angle (°)	Finish Angle (°)	Degrees to max Force (°)	Degrees to 70% of max Force (°)	Power (W)	Boat speed (m/s)
1	84.6 (2.53)	-51.1* (2.32)	33.8 (2.55)	29.4 (4.55)	13.9 (1.88)	333.9 (41.07)	4.61
2	85.0 (2.15)	-51.6* (2.13)	33.6 (2.15)	29.7 (4.98)	13.6 (2.55)	343.3 (28.66)	4.72
3	87.4 (2.36)	-55.1* (2.52)	32.8 (2.89)	36.4 (4.09)	14.2 (3.20)	367.9 (28.88)	5.58

* shows significant change ($p < 0.05$) between Trial 1, 2 and 3.

DISCUSSION:

Results showed that, of the six biomechanical characteristics measured, only catch angle showed significant change, although arc length and Power (W) showed positive trends. The lack of significant change was not expected since Magill (2001) suggested that concurrent augmented feedback enhances task-intrinsic (perceptual) feedback and therefore enhances skill learning. When relevant features of the perceptual feedback were enhanced using concurrent augmented feedback, skill learning was also enhanced. For example, the activation of specific muscle groups at specific times (Brucker and Bulaeva, 1996) which is required by rowing. The absence of significant change could explained by the small participant population (n=8) which increases the likelihood that no difference in relationship between trials is found.

Magill (2001) also suggested that in order for learning to be retained on a long term basis, delayed feedback of the results should also be used. Allowing time for the athletes to reflect on their performances in relation to task-intrinsic feedback positively influences learning (Magill, 2001). Magill (2001) also warned that further use of concurrent verbal augmented feedback should be used with caution, since concurrent augmented feedback commonly produces a negative learning retention effect when learners direct their attention away from the perceptual feedback.

CONCLUSION:

Although most biomechanical variables did not significantly improve, boat speed (the most important measure of rowing performance) increased by 18.2% between Trials 2 and 3 than between Trials 1 and 2. This change meant the athletes and coach still viewed the concurrent feedback method to be the best for improving performance and continued to use it in preparation for competitions. To ensure these coaching methods are fully effective and further enhance the learning experience of athletes in future work, data collection and analysis of performance should be repeated after a significant time period to enable evaluation of skill retention.

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