CONSISTENCY IN STROKE SYNCHRONISATION PATTERNS OF CREW-BOAT (K2) SPRINT KAYAKING OVER A FOUR-WEEK PERIOD

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The purpose of this study was to compare the stroke synchronisation patterns of a sprint kayak crew (two-seater K2) over a four-week pre-competition period. This case study centred on two female paddlers from a national sprint kayak team. High-speed (120 Hz) sagittal-view videos were recorded of a 200-m timetrial each week, for four weeks. Video analysis identified the extent of stroke synchronisation within the crew at four key positions of the stroke cycle (catch, immersion, extraction and release). Results showed similar patterns of offset across the four sessions, whereby the back paddler was either in time or slower to reach the catch position (91% of all strokes analysed), but faster to reach the release position (81% of all strokes analysed). It is likely that an experienced sprint kayak crew may be identified by their stroke synchronisation pattern.

KEY WORDS: team boat, offset, paddling, technique, K2.

INTRODUCTION: Crew-boat racing is widely practiced around the world in various forms; from the standard 20-crew dragon boat in many parts of Asia, to the rowing 'eights' and the four-seater sprint kayak (K4). In Olympic sprint kayaking, the smallest unit of a crew-boat, also known as a team-boat, is the two-seater K2. Two sprint kayakers each uses a double-bladed paddle to perform cyclical repetitions of a forward stroke on alternate sides to propel the kayak. The boat dimensions impose a requirement for some degree of stroke synchronisation such that the athletes do not clash their paddles. Thus, this need for effort coordination makes crew-boat racing an interacting team sport (Widmeyer & Williams, 1991). Interestingly, much has been debated about the ideal crew-boat technique but few investigative studies were reported in the literature. It is widely thought that perfect synchronisation is critical to successful crew-boat racing (e.g. Wing & Woodburn, 1995; Fothergill, Harle & Holden, 2008), yet others believe a slight asynchronicity in the actions of the paddle blades are ideal (e.g. Martin & Bernfield, 1980; de Brouwer, de Poel & Hofmijster, 2013). de Brouwer and colleagues (2013) were the first to investigate synchronous versus asynchronous rhythm on rowing performance by testing rowing pairs on coupled ergometers. Even without special training, crews experienced on average 5% decrease in power loss during a one-off testing utilising the asynchronous rhythm, implying better efficiency. Before such studies are conducted on sprint kayak crews, it is important to first identify the stroke synchronisation patterns that are currently in use. In addition, there is a need to establish the consistency of these synchronisation patterns. The purpose of this study was to present the stroke synchronisation patterns of a sprint kayak K2 crew across a four-week pre-competition training period. Findings from the study would contribute to the understanding of crew-boat racing technique.

METHODS: An observational study was conducted on sprint kayakers of a national team during a four-week training period leading up to a regional multi-sport games. This case study presents a crew of two female paddlers: Participant A (24 years old, height 1.63 m, weight 60 kg) and Participant B (25 years old, height 1.60 m, weight 49 kg). Both paddlers have kayaked competitively for 9 years, and have been practising as a K2 crew for 7 years. As a crew, participant A is the front paddler and participant B is the back paddler. The crew has achieved regional success in Southeast Asia, and are ranked among the top 9 in Asia.
Data collection took place during one session each week, for four weeks. High-speed (120 Hz) sagittal-view video recording of a 200-m timetrial was taken by a researcher on an accompanying speed boat. This recording method was previously used to video elite

kayakers by two independent research groups (Robinson, Holt, Pelham & Furneaux, 2011; Wainwright, Cooke & Low, 2015). The 200-m distance was chosen as it is the shortest contested race distance in sprint kayaking, hence being a good platform to begin with. Video analysis was performed to identify the extent of stroke synchronisation at four key positions of the stroke cycle (catch, immersion, extraction and release) as illustrated in Figure 1. The positions follow the proposed model by McDonnell, Hume and Nolte (2012).

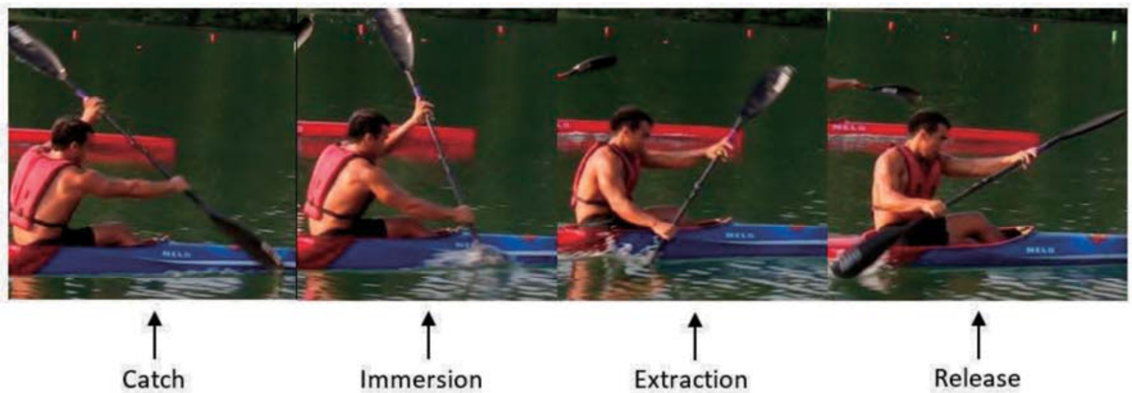

Figure 1: Four key positions (catch, immersion, extraction and release) of the kayak forward stroke. The catch occurred at the first instance of contact between the paddle blade and water, immersion occurred when the blade was maximally submerged, extraction was the last instance where the blade was maximally submerged, and the release was the last instance of contact between the blade and water.

To quantify stroke synchronisation within a crew, we introduced an offset variable defined as the timing difference of the back paddler with reference to the front paddler in a K2. As shown in Figure 2a (top), a positive offset occurs when the front paddler catches before the back paddler. Conversely, Figure 2b (bottom) shows a negative offset at the release position, where the back paddler's blade has exited the water before the front paddler. The offset is zero if both paddlers reached the same position at the same time. The offset was measured and analysed for each of the four positions for every complete stroke, except for the first three acceleration strokes based on pilot data. All offset values were reported, since there are no existing reference standards to interpret stroke synchronisation data.

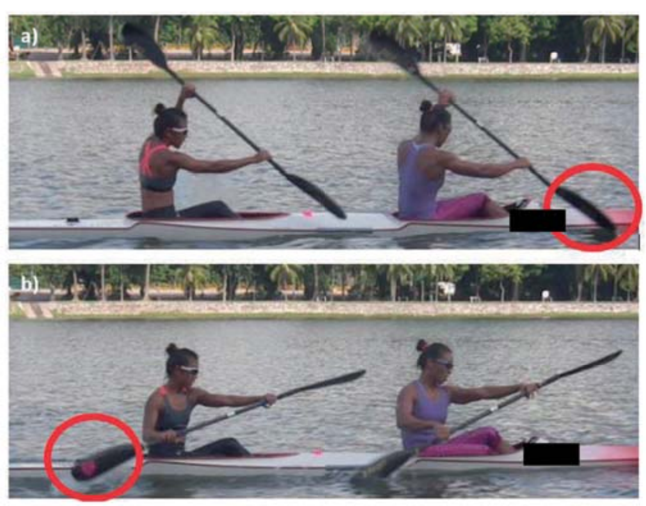

Figure 2: Offset in stroke synchronisation for a sprint kayak crew (a) Positive offset, where the front paddler's blade contacts the water before the back paddler's (b) Negative offset, where the back paddler's blade exits the water before the front paddler's.

RESULTS: Across the four sessions over the four-week period, the 200-m timings ranged between 41.1 to 41.7 s. These timings are comparable to the 9th position for the women's K2 200 m 'A' Final at the 2015 International Canoe Federation Canoe Sprint World Championships. Figure 3 illustrates that the four sets of stroke synchronisation data have a similar pattern, whereby the back paddler was either in time or slower to reach the catch position (91% of all strokes analysed), but faster to reach the release position (81% of all strokes analysed). The smallest amounts of offset were observed at the catch position, i.e., the crew was closest to perfect synchronisation at that position within the stroke cycle.

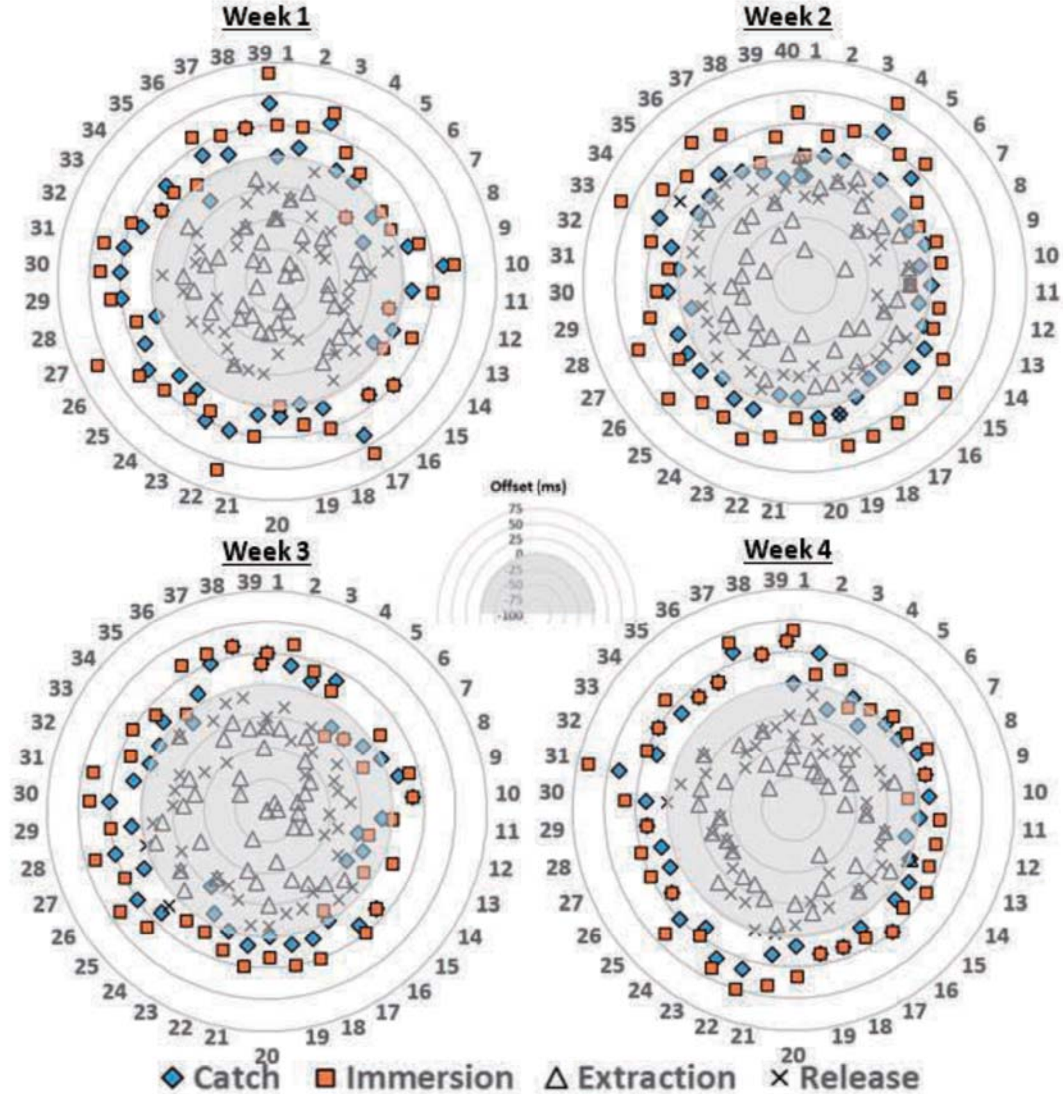

Figure 3: Offset patterns of a sprint kayak crew for four sessions over a four-week period. The outer rim shows the individual strokes. Data in the grey area represents negative offset, while those in the white area show positive offset. The general pattern is that the back paddler catches later (negative offset) but releases earlier (positive offset) than the front paddler.

DISCUSSION: Our findings revealed that an experienced sprint kayak crew performed a similar offset pattern over a four-week pre-competition period. Since there are no existing reference standards to interpret stroke synchronisation, the results provide reference values for comparison. Pertaining to the crew in our study, this also serves as a baseline for future interventions e.g. to compare well-synchronised versus asynchronous patterns similar to the rowing study by de Brouwer, de Poel and Hofmijster (2013). Furthermore, the specific offset pattern displayed by the crew (almost perfect synchronisation at the initial part (catch) of the stroke cycle, but less synchronised at the other positions) provides a new dimension to the debate on the ideal for crew-boat racing. Previously, the two schools of thought were either supporting perfect synchronisation (e.g. Wing & Woodburn, 1995; Fothergill, Harle & Holden, 2008) or a slight asynchronicity in all phases of the stroke cycle (e.g. Martin & Bernfield, 1980; de Brouwer, de Poel & Hofmijster, 2013). Perhaps, it is important to consider that the degree of stroke synchronisation changes within a stroke cycle.

Future studies may also consider both experimental and theoretical approaches to identify how differences in stroke synchronisation patterns would affect crew-boat performance. Our study was delimited to K2 200-m racing, however, it should not be assumed that these findings would apply to larger crew-boats (K4) or the other Olympic distances (500- and 1000-m). The current methods are laborious, subject to human error in the video digitisation process, and difficult to scale up to a larger group of athletes. One solution is to implement technology, such as instrumented paddles that can be synced to obtain on-water force measurements from the crew, and accelerometers to measure instantaneous boat speed.

CONCLUSION: This study presented the stroke synchronisation patterns of a sprint kayak crew (two-seater K2) over a four-week pre-competition period. It is likely that an experienced sprint kayak crew has a consistent stroke synchronisation (offset) pattern. Future investigations are needed to identify how these patterns may be adapted for successful crew-boat performance.

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