TRAINING FOR THE BIKE TO RUN TRANSITION IN TRIATHLON

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The purpose of this study was to examine the effect of a practice regimen that targets the bike-to-run transition for triathlons; known as brick workouts. The principle of specificity suggests that since this skill is a critical transition in a triathlon, having further impact on the subsequent running section, practicing this skill is vital for success. Moreover, the identification of performance parameters that quantify a successful transition will serve to maximize practice efficiency. Subjects (N=12) performed either brick workouts or single event training, to examine their effects on the bike-run transition. Our results indicate that the brick workouts had a positive effect by eliciting an increased adaptability in knee behavior in response to the transition from cycling to running. Quicker adoption of efficient running mechanics may ensue, leading to less fatigue and greater performance.

KEY WORDS: approximate entropy, transition, brick, movement, training, triathlon.

INTRODUCTION:

Transitioning from biking to running during a triathlon can be a difficult endeavor for a novice, or even a professional triathlete. The difficulty in this transition is highlighted by the retention of the movement pattern characteristic of biking, well into the initiation of the running segment. At minimum, easing this transition can bring added comfort to the athlete, and at maximum it could mean the energetic difference between victory and defeat. As known in the triathlete community as the “brick” workout, this type of transition training focuses on the repeated alternation of bike and run training during a single practice session. This is in stark contrast to the traditional training approach of single skill training during separate practice sessions, where the transition phase receives little attention. Brick training brings specific practice efforts to the optimization of the transition phase, in order to alleviate the carry-over detrimental effects of distance cycling on the subsequent running performance. However, even though brick training is developing wide spread use in the triathlon community, and is strongly purported by the principle of specificity, no definitive research could be found to support the use of brick workouts and its effects on running performance following the bike-run transition. Thus, the purpose of this research was to document the effectiveness of brick workouts, while concurrently presenting a novel measure of performance which could continue to benefit the analysis of triathletes' performance.

METHOD:

Participants and Grouping:

Seven male and five female college-aged triathletes were split randomly into two groups (experimental brick training group & control training group). Maximal oxygen uptake (VO_{2Max}) was recorded pre-post training in order to ensure standardized fitness between groups.

Procedures: Triathletes in both groups engaged in 6 weeks of triathlon preparation using one of two training methods; brick or traditional. Relative practice intensity was maintained between the groups by providing similar training volumes during specific practice (2 hours per week), documentation of miles and minutes of training outside of the specific practice (both cycling and running), and the instructed regulation of 80% heart rate max during specific practice.

The brick training group practiced the run-bike transition by performing transition training, alternating 10 minute bike with 10 minute run, for one hour twice each week. The traditional training group practiced bike and run workouts for one hour each week, on separate days. SIMI motion analysis was used to record lower extremity kinematics (at 60 Hz) during each triathlete's initial running performance after the bike-run transition, both pre and post 6 weeks of training. For both tests, participants cycled for 40 minutes at 90% max heart rate (to simulate true race conditions), and were then filmed for the first minute of the following run. To aid in digitizing, retroreflective markers were fixed to known body landmarks of the lower extremity (greater trochanter, lateral epichondyle, and lateral maleolus). SIMI was also used for manual digitization and calculation of knee angle; used for subsequent analysis.

Design: The current investigation utilized a 2 X 2 design (time X training), with a corresponding ANOVA used to test for differences across three dependant variables. Time (the within subjects factor) had two levels, pre and post training. Training type (the between subjects factor) also had two levels, traditional and brick training. Three dependent variables were calculated from the knee angle data collected during the first minute of running following the transistion phase from a 40 minute bout of cycling. Dependent variables included 1) knee angle range (max – min knee angle position), 2) knee angle coefficient of variability (standard deviation of position/mean position), and 3) approximate entropy (ApEn; a nonlinear measure of knee angle temporal predictability, i.e. consistency of position during recurrent cycles).

Approximate Entropy (ApEn)**:** This value characterizes the complexity of variability within the signal; the degree to which a signal remains self-similar through time (Vaillancourt, Newell, 2000). Higher values indicate that the behavior is irregular and lower values indicate maintained consistency. ApEn is computed using algorithms by Pincus (1994), implemented in MATLAB. Stergiou (2004) report that ApEn is useful for characterizing the health and optimal performance of a biological system including heart rhythm, standing posture, and gait.

ApEn has been used to examine heart rate complexity proceeding atrial fibrillation showing that a period of very low ApEn precedes atrial fibrillation (Tuzcu, 2006). Studies of postural control have found that after cerebral concussion an athlete's center of pressure oscillations, measured by ApEn, are significantly more rigid up to 96 hours post-injury, even when the athlete appears steady (Cavanaugh, 2006).

Analysis: Linear analysis of knee angle was performed by calculating the average of both range and coefficient of variability for each group during the first minute of running after 40 minutes of cycling, both pre and post training. Non-linear analysis was calculated across the whole of the first minute of running after the transition phase.

RESULTS:

No overall group changes in VO_{2Max} were observed. In addition, exercise outside of the training protocol did not vary between groups. Linear analysis of knee angle range and coefficient of variability showed no measureable difference for the two conditions within groups (Figures 1 & 2), indicating that the knee moved within the same volume of space regardless of the training. However, the non-linear measurement of ApEn (Figure 3) showed a difference between pre and post training within the brick training group, t (5) = -3.49, p=0.017, but not for the traditional training group, t (5) = 0.49, p=0.640. The change in ApEn value indicated that the brick training group experienced changes to the temporal organization of knee movement, decreased rigidity, as a result of training. Although pre-test values exhibit differences between the two groups, the study participants were quite similar in terms of age, experience, and anthropometrics and were placed randomly into the groups. Moreover, the goal of this study is to focus on changes in performance due to training type. Further investigation and analysis may be needed to uncover the source of an athlete's specific *a priori* mechanical approach to running.

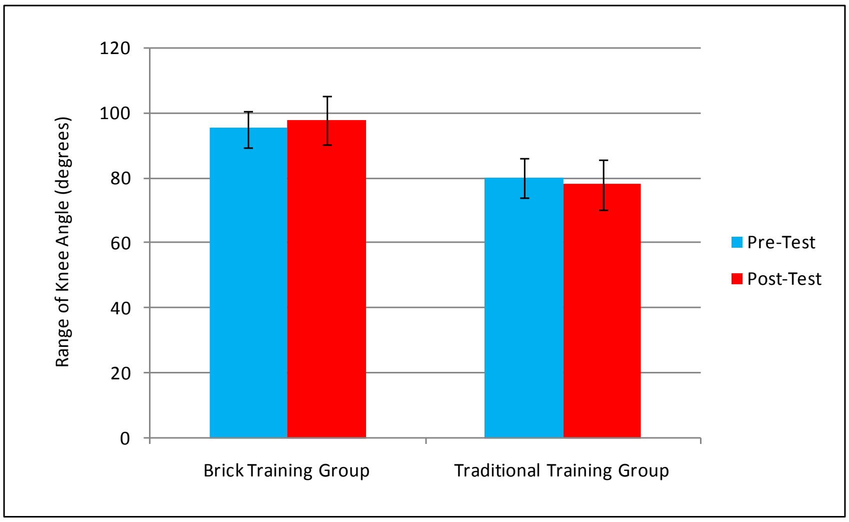

Figure 1: Knee Angle Range

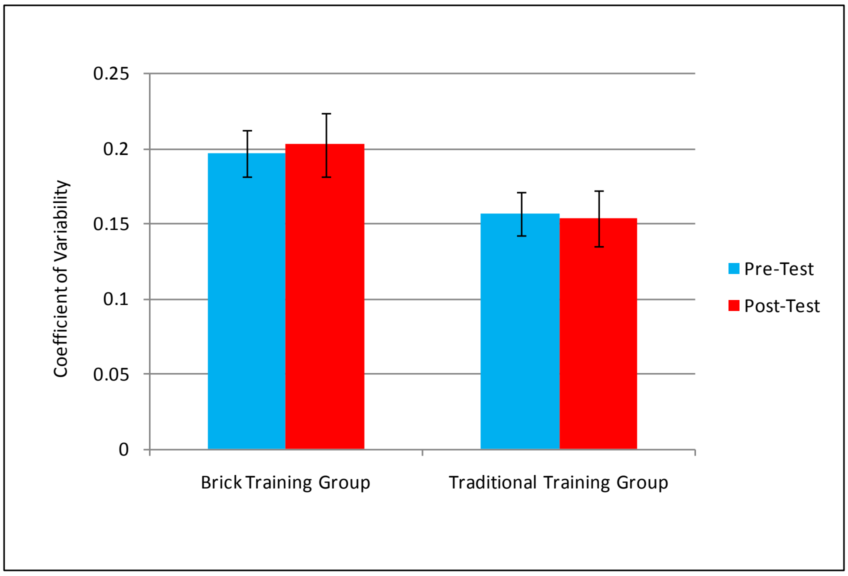

Figure 2: Knee Angle Coefficient of Variability

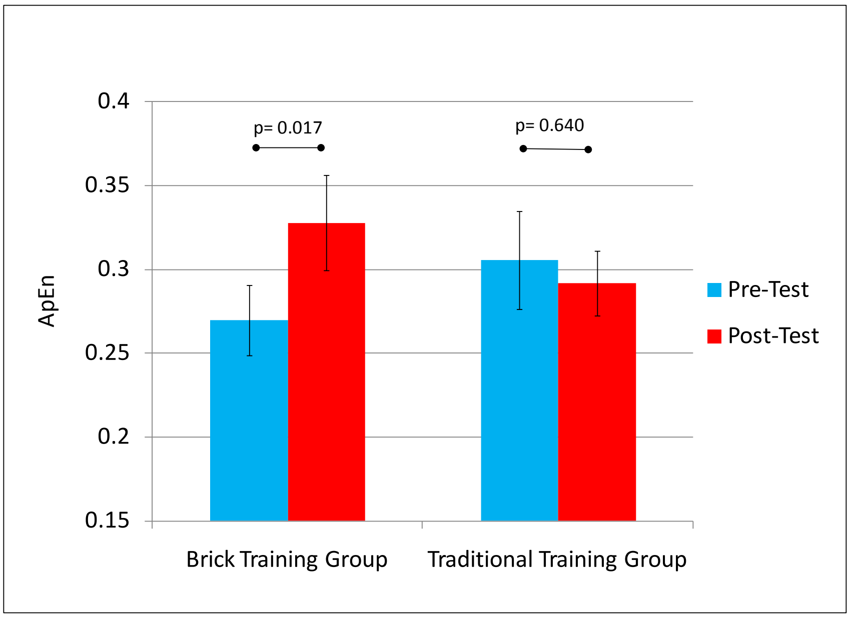

Figure 3: Knee Angle ApEn

DISCUSSION: Approximate entropy characterizes the regularity, or predictability, of a behavior. Lower values of ApEn indicate a system that is highly recurrent, repeating nearly the identical behavior throughout subsequent iterations. What this means in terms of running mechanics, is that lower ApEn values indicate rigid, non-adaptive strategies. Specifically in the context of the bike-run transition phase of the triathlon, this rigidity indicates a reduced ability of the neuromuscular system to transition from cycling mechanics to running mechanics, due to being "stuck" in the repeated engagement of cycling behavior. Slowed, inefficient transitions between these performance mechanics cause drastic deficits to performance, serving as a source of pain and discomfort and increasing propensity for injury. Additionally, the perseverance of cycling mechanics into the running section is quite expensive, leading to large consumptions of oxygen and energy that could instead be used to heighten the athlete's performance.

The increased values of ApEn found following brick training suggest that individuals in this group have acquired a new, transition-specific flexibility in knee angle behavior. Reduced rigidity following the cycling section of the race will allow for a quicker, smoother, and more efficient transition into steady state running mechanics. Coupled with the observation of unchanged range and coefficient of variation, these results suggest that it is the temporal organization of knee joint behavior which differs after training, with the opportunity to influence performance.

CONCLUSION: The decreased rigidity in knee movement behavior found after training for the transition through brick workouts reflects an increase in fluidity and flexibility of movement. Increasing knee angle ApEn indicates greater adaptability during the run after the transition, indicating the potential for quicker, more efficient transitions into steady state running mechanics. It is important to mention that linear analysis was unable to detect these subtle changes that occur resulting from brick training. Non-linear analysis may detect this information readily and help to explain why so many triathletes participate in brick training. Upon further investigation, ApEn may become a critical evaluative measure of performance for triathletes.

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