TEMPORAL PATTERN CHANGES WITH SPEED IN CROSS-COUNTRY SKIING

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INTRODUCTION

The purpose of this study was to investigate the temporal patterns in classical and freestyle cross-country skiing movement cycles and their adaptation to speed.

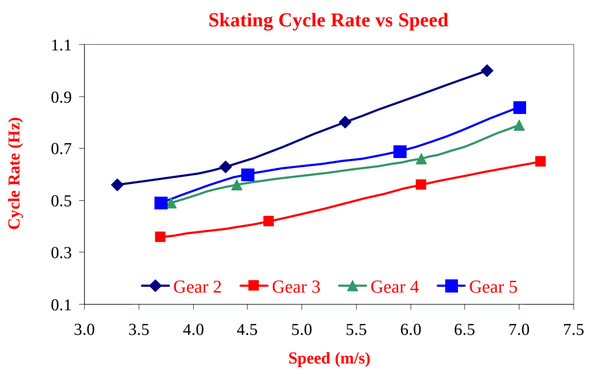
METHODS

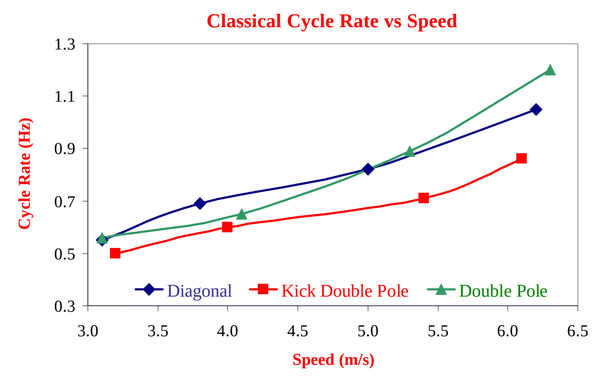
Eight skilled male cross-country skiers volunteered as subjects in the study with mean age, height and weight (range) of 25 yrs (19-37 yrs) , 1.83 m (1.75-1.89 m) and 77 kg (68-92 kg) respectively. A flat snow strip approximately 60 m long and 5 m wide was prepared for classical and freestyle cross-country skiing. The subjects performed three classical and four freestyle techniques in the order; diagonal stride, double poling, kick double poling, gear 2 ”paddle dance”, gear 3 ”double dance” gear 4 “single dance” and gear 5 “combiskate”. The techniques were performed at four speed levels in the order; low, medium, high and maximum speed. These correspond to the mean speeds 3.2, 4.1, 5.3 and 6.2 $m \cdot s^{-1}$, respectively in the classical style. The corresponding values in free style. were a bit higher: 3.6, 4.5, 5.9 and 7.0 ms^{-1}. The subjects were recorded with a digital video camera (Panasonic DV, AG-EZ1E) at 50 frames per second. The determination of movement phases, analyses of the temporal patterns and average speeds were performed by means of a video analysis system. Cycle duration, cycle rate, cycle length, relative and absolute phase duration at different speeds were calculated.

RESULTS

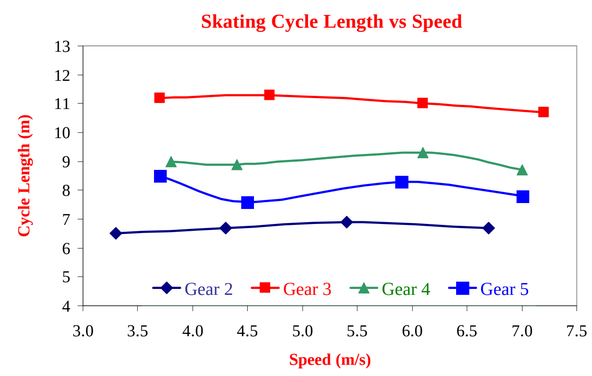
Skiing speeds ranged between about 3 and 7 m·s-1. At maximum, similar speeds were attained for each of the classical techniques (about 6.2 m·s-1) and each of the skating techniques (about 7.0 m·s-1). Cycle rate was found to increase continuously with speed from about 0.5 to about 1.0 Hz. Across both classical and skating techniques substantial increases in cycle rate ranging from 60% to more than 90% were observed as speed increased.

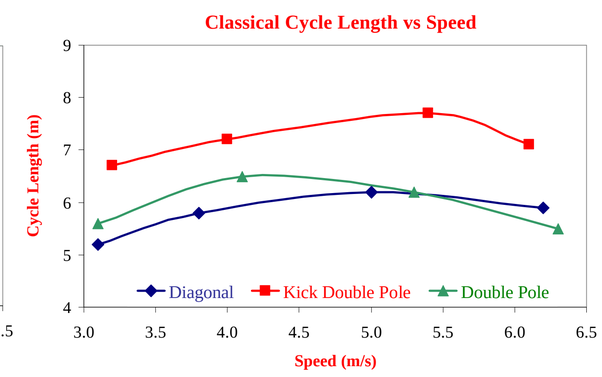
In contrast, only small changes in cycle length occurred across speed for the classical techniques (at most 15%) while cycle length was nearly constant for the skating techniques. Thus, **individual skier control of speed is largely through adjustment of cycle rate while cycle length changes are relatively small.**





Figures 1 and 2. Cycle rate increased substantially with skiing speed for every technique.





Figures 3 and 4. Cycle length changed relatively little with skiing speed for the skating techniques and increased at most 15% for the classical techniques.

The phases that comprise a cycle of any of the ski techniques were measured in both absolute and relative terms. Cycle times consistently decreased (i.e. cycle rate increased) as speed increased, so also did each of the phases of a cycle. Relative to cycle time however, **phases of both classical and skating techniques were remarkably similar across the range of speeds**. Thus each of the technique movement patterns was independent of speed in its proportions.

DISCUSSION

Temporal characteristics of movement patterns describe some of the most fundamental aspects of locomotion. In skiing, the various techniques are well defined patterns which are invariant across speed. This has implications for learning and training in that it allows skiers to develop the motor control patterns at relatively slow speeds and apply them in faster skiing.

In addition, control of speed in skiing is primarily a function of cycle rate. To ski faster, the tempo or rate is increased. Speed and cycle rate are directly related while cycle length is nearly constant. This control mechanism is quite different from running for example where through the range of distance running speeds stride length is the primary control variable.