CHANGES IN SPLIT VELOCITIES DURING SPRINT PERFORMANCE DEVELOPMENT

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Sprint times and split velocities are invaluable measures for coaches and athletes monitoring sprint training and performance development. This study analysed sprint times and 10 m split velocities as performance of three developing athletes developed over a five week training period. All significantly improved their 60 m sprint times over the training period (p < 0.05). Sprint performance developed individually with a tendency for maximal velocities to increase early in the training period and start and acceleration velocities later. All athletes' performances fluctuated between weeks, possibly due to a period of experimental learning in their process of skill development. This study will inform further analysis of the kinematic and kinetic parameters determining velocity, with the aim of identifying the key variables responsible for these changes.

KEYWORDS: Athletics, speed, split times

INTRODUCTION: The fundamental aim of sprint training is to decrease sprint time over a set distance, commonly, 60, 100 or 200 m. For an athlete to improve they must either increase sprint velocity or be able to sustain maximum velocity for a longer distance. Consequently, in addition to sprint times, it is valuable for coaches and athletes to have feedback of split times and average split velocities throughout the sprint. Such information will enable identification of weaknesses in an athlete's performance and aid the monitoring and evaluation of training progress and interventions.

Previous studies have concentrated on cross-sectional analyses of velocities (e.g. Mann & Herman, 1985; Ae et al., 1994); few have used a longitudinal approach to monitor sprint performance development. As part ongoing research into sprinting biomechanics, this longitudinal study focused on the early stages of training and in particular on how an athlete's velocity profile changes as technique develops and performance improves. Such insights will support sprint training, particularly in developing athletes and will potentially enhance training efficiency (Young et al., 2001). Additionally, velocity analysis over an entire 60 m run, and encompassing each sprint phase, will provide insights into where and how velocities vary during individual and series sprints. Such information has not been readily available due to the lack of availability of the necessary measurement technology and the phase-specific nature of previous sprint studies. Further understanding of how the velocity profile changes as sprint performance develops will also inform subsequent analysis of kinematic and kinetic parameters determining velocity, with the aim of identifying the key variables responsible for changes. The aim of this study was to examine how split velocities varied as performances developed for a group of non-sprint specific athletes over a five week training period. Non-sprint specific athletes were used to ensure performance developments were made over this time.

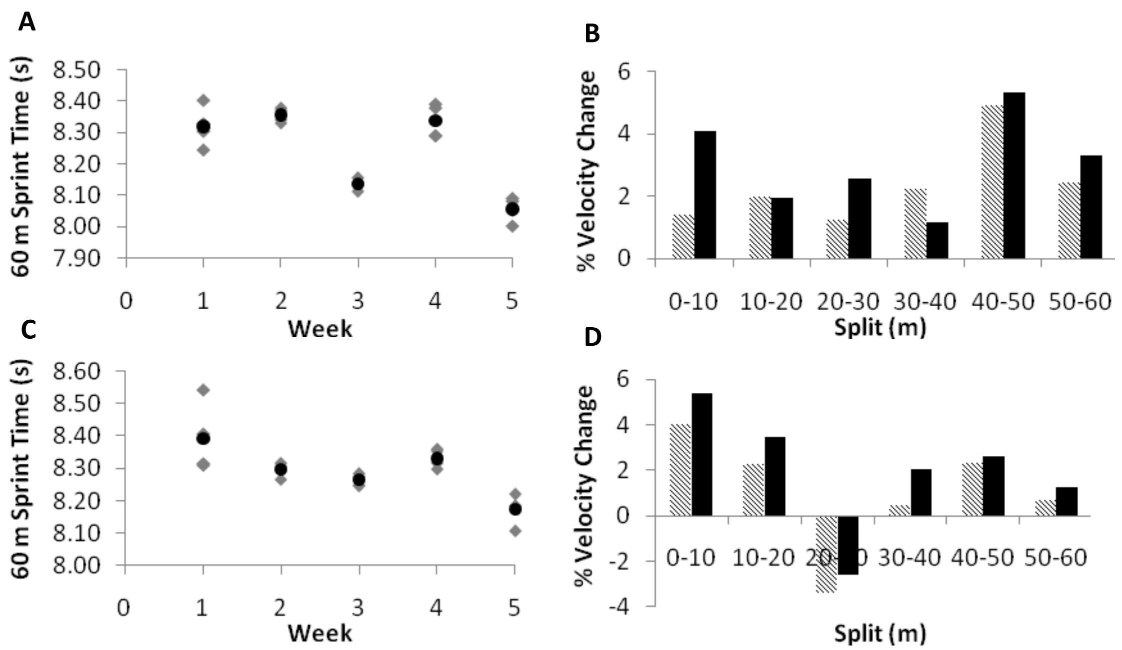
METHOD: **Collection:** Three male recreational athletes (Athlete 1: height 1.81 m, mass 87.7 kg, age 19 yrs, 60 m personal best (PB) 8.09 s; Athlete 2: 1.75 m, 75.6 kg, 20 yrs, 8.10 s; Athlete 3: 1.70 m, 71.1 kg, 19 yrs, 8.65 s) gave written informed consent to participate in the study. The athletes had no history of serious or recent injuries and were fit for the duration of data collection. They trained at an indoor athletics centre twice a week for five weeks, completing five 60 m sprints per session against fellow developing athletes. During each session, separated by at least three days, the athletes performed a similar warm up and wore the same running shoes. A ceiling mounted light gate timing system (PLG, Cheng et al., 2010) was used to record six '10 m splits' for each trial and the athletes were provided with their sprint times following every trial. The 10 m splits corresponded approximately with different phases of sprint performance: Start (0-10 m), acceleration (10-20 & 20-30 m), high velocity (30-40 m) and maximum velocity (40-50 m & 50-60 m). A block start was initiated by an audible signal (hooter). Rest between each trial was never less than 5 minutes, minimising the effects of fatigue.

Sprint times for 60 m and 10 m split times were output by the PLG system and average velocities for each 10 m were calculated from the split times. The athletes' four fastest sprints per week were selected for all analyses. Mean ± SD sprint times and split velocities were calculated for each of the five weeks. Significant differences in sprint times and split velocities were identified using Repeated Measures ANOVA with Bonferroni correction for repeated measures. The level of significance (p) was set *a priori* to 0.05.

RESULTS: Over the five week training period the athletes PB 60 m times improved significantly (Table 1). The average 60 m time decreased significantly ($p < 0.05$) over the training period (Table 1 & Figure 1). Differences in velocity were evident and percentage change between Week 1 and Weeks 3 and 5 are displayed (Figure 1). Table 2 presents the statistically significant mean differences in split velocities over the five weeks.

Table 1. 60 m PB and mean (±SD) of the four fastest sprints for each week and the mean difference between weeks 1-5 (* p < 0.05)

		Week					Mean
Athlete		1	2	3	4	5	Difference
1	Best 60 m time (s)	8.24	8.33	8.11	8.29	8.00	
	Mean 60 m time (s)	8.32	8.36	8.14	8.34	8.06	0.26*
	SD	0.06	0.02	0.02	0.05	0.04	
2	Best 60 m time (s)	8.31	8.27	8.25	8.30	8.11	
	Mean 60 m time (s)	8.39	8.30	8.26	8.33	8.17	0.22*
	SD	0.11	0.02	0.02	0.03	0.05	
3	Best 60 m time (s)	8.95	8.75	8.67	8.66	8.66	
	Mean 60 m time (s)	8.99	8.80	8.74	8.78	8.69	0.30*
	SD	0.04	0.06	0.08	0.08	0.02	



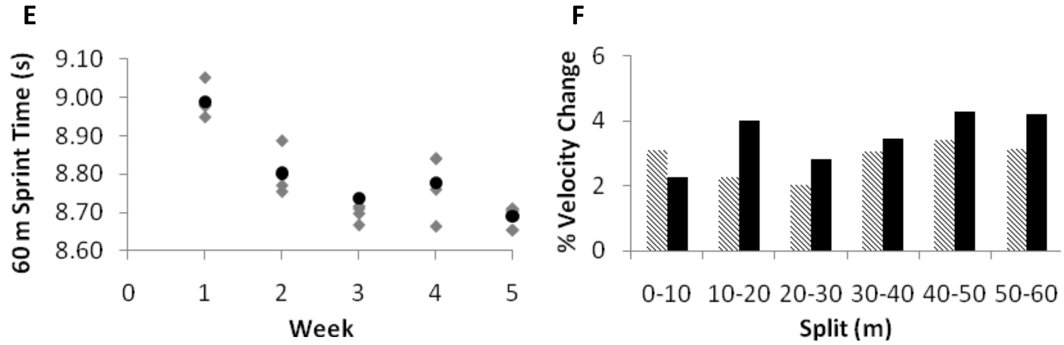


Figure 1. A, C, E: 60 m sprint times (◆) and mean per week (●). B, D, F: Percentage velocity change between split velocities in the first, mid and last weeks. The shaded bars indicate change weeks 1 - 3 and black weeks 1 - 5. Results are for the best four sprints from each week for athletes 1 (A & B), 2 (C & D) and 3 (E & F).

Table 2. Significant (*p* < 0.05) mean differences (a-b) in split velocities between weeks.

	Athlete 1			Athlete 2			Athlete 3		
Phase	Week	Week	(a-b)	Week	Week	(a-b)	Week	Week	(a-b)
0-10	5	1	0.18	5	1	0.24	3	1	0.13
		2	0.17						
		4	0.20						
10-20	4	3	-0.31	5	1	0.27	5	1	0.30
		5	-0.31		4	0.18	5	3	0.13
20-30	5	1	0.22						
		2	0.41						
		4	0.21						
30-40	4	3	-0.28	5	2	0.21	5	1	0.28
		5	-0.19		4	0.26		2	0.26
40-50	3	1	0.41	3	4	0.18	4	2	0.13
		2	0.33	5	1	0.22	5	1	0.35
		4	0.33		4	0.21		2	0.21
	5	1	0.47						
		2	0.39						
		4	0.38						
50-60	5	1	0.29				3	1	0.24
		2	0.36				4	1	0.25
							5	1	0.35

DISCUSSION: This study used case studies of three developing athletes to monitor sprint times and split velocities over a five week training period. The aim was to identify specific patterns in improvement of sprint time and velocity, informing the coach and further research. The changes in sprint times (Table 1) indicate the athletes improved their sprinting abilities over the ten session training period. Figure 1 illustrates how 60 m sprint times decreased due to increases in velocity across weeks 1 – 5. Figure 1 also reveals that performance improvement did not occur between every week and this is particularly evident where Week 4 times decrease from the times of Week 3 in all three cases. However, despite these apparently undulating sprint times, performance between the beginning, middle and end of the training period improved. The rate of this improvement is particularly consistent in athletes 1 and 2. Further analysis is required to understand why sprint performance varied to the extent it did here but this may be explained by the athletes' stage of learning. Collectively, these analyses indicate recreational athletes' sprint performance can be improved over a five week period but variations should be expected within this time (Newell et al., 2001). It is of interest to both coaches and researchers to understand how an athlete develops sprinting ability and identification of split velocity changes (Figure 1 & Table 2) over the training period will add insight to this.

Although faster average velocities were found for most splits as each athlete's performance improved, only the significantly different (*p* < 0.05) velocities are discussed here.

The development in Athlete 1's sprint performance by Week 3 can be attributed to a significantly higher maximum velocity (40-50 m). The further improvement by Week 5 is due to a faster start (0-10 m) and continued development in the maximum velocity achieved (40-

50 m) and maintained (50-60 m). The slow performances of Weeks 2 and 4 are due to slower acceleration (10-20 m) and high velocity (30-40 m) phases.

Athlete 2 achieved no significant improvements in average split velocities until the final week of training. Improvements in the start (0-10 m), acceleration (10-20 m) and maximum velocity (40-50 m) phases were then evident. Surprisingly, as Athlete 2 developed his sprinting ability, average velocity over the 20-30 m split decreased throughout the training period. Further analysis is required here but this may be indicative of changes in technique in acceleration affecting the transition into maximum velocity.

Athlete 3 showed an initial improvement in his start (0-10 m) which was followed by decrements between Weeks 3 and 5. This may indicate that Athlete 3 required a longer period of training to refine this particular skill. Conversely, he may have altered his starting technique to improve his acceleration phase, which did increase in velocity from Weeks 3 - 5 (0.13 s). Athlete 3 also increased average velocity in the high and maximum velocity phases. He improved his ability to maintain maximum velocity earlier in the training period (Week 3) than he was able to significantly increase the maximum (40-50 m, Week 4) and high (30-40 m, Week 5) velocities.

In summary, all three athletes improved their sprinting ability at different rates and through development at different phases of the sprint. Initial improvements in performances were largely due to improved split velocities at high (30-40 m) and maximal (40-50 m) velocity whereas decreased sprint times later in the period were due to slight increases in maximal velocity but also large improvements in the start (0-10 m) and/or early acceleration (10-20 m) phases. Athletes 1 and 2 showed no significant improvement in their start phase until the last week of training, perhaps suggesting the start is a difficult phase to improve and a greater level of technical skill may require more practice than the later more familiar phases. All three athletes demonstrated a trend towards increased maximum velocity and maintenance of velocity as performance improved.

Variations in sprint performance, particularly evident in Week 4 for all subjects, could be an essential part of improving sprint technique. Such patterns may be due to the athlete entering an experimental time while learning and developing their technique (Wilson et al., 2008). The changes reported in this study were possible without any technical feedback available to the athlete. Development of a quantitative method of technical feedback of variables determined as key to improving sprint performance may enable athletes to develop their technique beyond the rate and level that their own proprioceptive ability can achieve. This may be particularly true for novice and developing athletes, or those without regular access to a high level of coaching expertise.

CONCLUSION: Collectively, these analyses indicate a recreational athlete's sprint performance can be improved over a five week period, but variations should be expected and may be necessary within this time. Further research of this type is required to enhance understanding of sprint performance development, extending knowledge for coaches aiming to enhance training specificity and efficiency.

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