A COMPARISON OF BASE RUNNING TECHNIQUES IN BASEBALL

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INTRODUCTION

Safe arrival at a base in baseball requires covering the distance between bases in a short time. Often it also requires stopping at the base, typically using head-first (HF) or feet-first (FF) sliding techniques. Previous research has found no time differences between these two techniques [1,2]. The purpose of this study was to compare the effectiveness of the two sliding techniques to running through the base (RT) and to running to a stop on the base (RS).

METHODS

Nine collegiate baseball players executed maximum effort runs from a lead-off position 13 ft (3.96 m) ahead of first base to second base using RT, HF, FF, and RS techniques. A video camera shooting at 60 Hz taped the entire run. The last 10 m of each run were also taped with two HD (1080i) cameras shooting at 50 Hz, and the 3D coordinates of 21 body landmarks were calculated using DLT. Landmark locations in the last 10 m were filtered with a 12 Hz cutoff frequency; center of mass (c.m.) locations were then calculated from the landmark locations.

The start of the run was defined as the instant when the trail foot left the ground. The times for the entire 22.90 m run (t\text{total}), the first 12.90 m (t\text{1290}) and the final 10 m (t\text{10}) were measured using video analysis.

In all trials, the c.m. was still short of the base at the instant of contact. Because of this, two velocities were computed for the last 10 m: effective velocity (v\text{eff}) and actual velocity (v\text{cm}), using the formulas $v_{\text{eff}} = \frac{10 \text{ m}}{t_{10}}$ and $v_{\text{cm}} = \frac{\Delta S_{\text{cm10}}}{t_{10}}$, where $\Delta S_{\text{cm10}}$ was the horizontal distance traveled by the c.m. between the instant when the c.m. reached a point 10 m from second base and the instant of first contact with the base. The difference between $v_{\text{eff}}$ and $v_{\text{cm}}$ represented a theoretical velocity gain ($v_{\text{bonus}}$) achieved by touching the base with a point of the body located at a certain distance ahead of the c.m. (“final reach”, $d_{\text{bonus}}$).

Average velocity of the c.m. was calculated for meter-long intervals in the last 10 meters prior to the base in each condition, from the interval 10-9 m away from the base to the interval 3-2 m away from the base. This yielded 8 interval velocities for each player in each condition.

Times and velocities were compared across conditions using repeated measures ANOVA. Tukey post-hoc tests were used to identify specific differences between means ($\alpha = .05$).

RESULTS AND DISCUSSION

No significant time differences were found between any of the conditions in the first 12.90 m of the run.

Comparisons between the four conditions for total time in the entire run and for time and effective velocity in the last 10 m showed that the RT condition was faster than FF and RS, but no significant differences were found between RT and HF nor between HF and FF. RS was slower than all other conditions. (See $t_{\text{total}}$, $t_{10}$ and $v_{\text{eff}}$ in Table 1.)

In regard to the actual velocity of the c.m. over the last 10 m, RT was the fastest condition, and RS the slowest; there were no significant differences between HF and FF. (See $v_{\text{cm}}$ in Table 1.)

The bonus velocity was linked to the reach distance. The HF condition produced the largest reach distance and bonus velocity in the samples, followed by FF, RS and RT, in that order. (See $d_{\text{bonus}}$ and $v_{\text{bonus}}$ in Table 1.) Statistically, the values were larger in HF than in RS and RT, and larger in FF than in RT.

The velocity of the RT condition showed a slightly increasing trend during the last 10 m, while the
other three conditions showed constant velocity followed by a marked slowing down in the last 3-7 m. (See Figure 1.) In the 10th meter prior to the base, the c.m. velocities of the four conditions showed no significant differences. In the 8th or 7th meter prior to the base, there were still no significant differences between RT and HF, between HF and FF, and between FF and RS, but RT was significantly faster than FF and RS, and HF was significantly faster than RS. (See the diagrams at the top of Figure 1.) In the 5th meter prior to the base, RS became significantly slower than all the other conditions, while the interrelationships between RT, HF and FF remained the same as before, with RT faster than FF, but no significant differences between RT and HF nor between HF and FF. In the 4th or 3rd meter prior to the base, RT became the fastest condition, RS remained the slowest, and there was still no significant difference between HF and FF. HF and FF showed no significant c.m. velocity differences in any of the one-meter intervals.

The RT condition produced a larger average c.m. velocity than the HF condition in the last 10 m. However, the larger final reach of the HF condition closed some of the velocity gap. Thus, the effective velocity was not significantly larger in RT than in HF (although it approached significance, and was in fact detectable by paired t-test with p < .01).

The FF condition had smaller c.m. velocity, final reach and effective velocity than HF, but the differences were not statistically significant. However, the effective velocity in the FF condition was significantly slower than in the RT condition.

The RS condition suffered the disadvantage of the smallest c.m. velocity and a small final reach. This combination produced a slower effective velocity for RS than for any other condition.

The times and effective velocities in the last 10 m clearly showed that the running through, feet-first, and run to a stop conditions are ranked in that order in regard to the time required for reaching the base, while the head-first condition is probably intermediate between the running-through and feet-first conditions. However, it is important to keep in mind that minimizing travel time between bases is not the only factor to be considered. Before deciding which technique to use, the player has to take into account the possible need to stop at the base, the need to avoid the baseman’s tag, keeping options open for possible further immediate play, and minimizing the risk of injury.

REFERENCES


<table>
<thead>
<tr>
<th>Condition</th>
<th>( t_{\text{total}} ) (s)</th>
<th>( t_{1290} ) (s)</th>
<th>( t_{10} ) (s)</th>
<th>( v_{\text{eff}} ) (m/s)</th>
<th>( v_{\text{cm}} ) (m/s)</th>
<th>( v_{\text{bonus}} ) (m/s)</th>
<th>( d_{\text{bonus}} ) (m)</th>
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<td>RT</td>
<td>3.275 ± .090</td>
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<td>HF</td>
<td>3.330 ± .104</td>
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