An Analysis of Velocity, Vertical Movement, and Pitch Sequencing on Changeup Success

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Introduction

Previous knowledge suggests that the most effective changeups achieve separation from the fastball in terms of both velocity and movement. There have been contrasting ideas about the importance of vertical break separation in determining the effectiveness of a changeup. The goal of this study is to determine the optimal velocity differential between a changeup and a fastball, to examine the effects of changeup vs. fastball vertical break, and to analyze the effectiveness of certain methods of pitch sequencing.

Pitch Movement

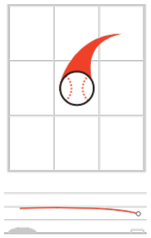

Figure 1. Fastball movement

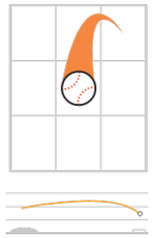

Figure 2. Changeup movement

Methods

Velocity & Vertical Movement Analysis:

Exit velocity and whiff rate were compared to the following metrics:

Metric	Formula
Velocity Differential	$Fastball\ Velocity\ -\ Changeup\ Velocity$
Vertical Break Proportion	$1 - \frac{Changeup\ Vertical\ Break}{Fastball\ Vertical\ Break}$

Pitch Sequencing Analysis:

Average exit velocity and whiff rates between the 1st, 2nd, and 3rd changeups thrown in a row were compared using a two-sample z-test.

Results

Velocity

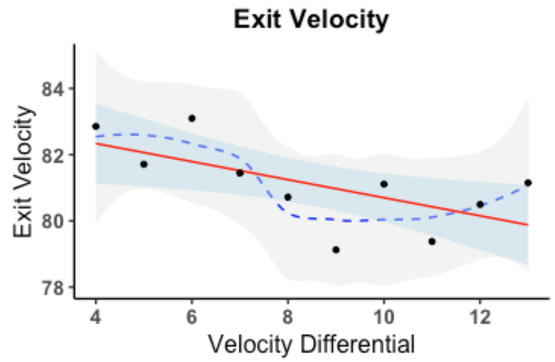

Figure 3. Exit velocity plotted against velocity differential.

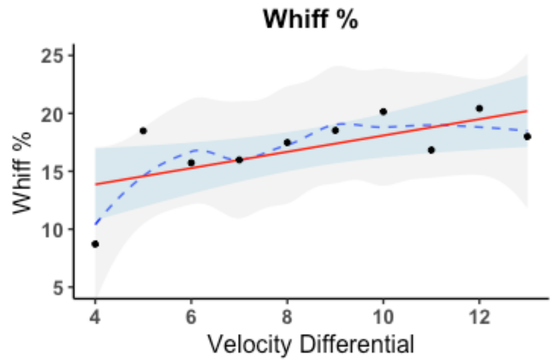

Figure 4. Whiff rate plotted against velocity differential.

Vertical Movement

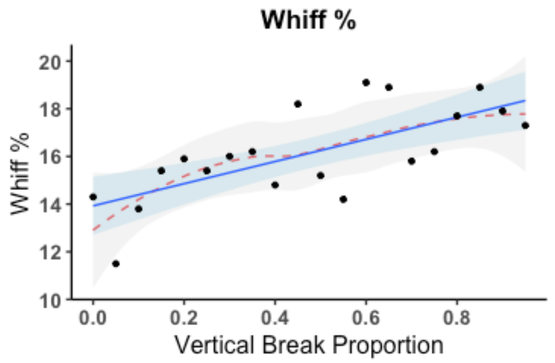

Figure 5. Whiff rate plotted against vertical break proportion.

Pitch Sequencing

	Exit Velocity	Whiff Rate
1st	83.98 mph	29.22%
2nd	78.41 mph	30.05%
3rd	83.08 mph	44.00%

Figure 6. Exit velocities and whiff rates for sequential changeups.

Figures 3-5 all exhibit statistically significant linear relationships between the two respective variables. Exit velocity and whiff rate can be predicted by the following equations:

$$Exit\ Velo\ = 83.43 - 0.27(Velo\ Diff)$$
$$Whiff\ \%\ = 11.05 + 0.70(Velo\ Diff)$$
$$Whiff\ \% = 13.9 + 4.6(VB\ Proportion)$$

Conclusions

Pitchers that maximize the separation between fastball and changeup velocity generally have lower exit velocities and higher whiff rates. Larger vertical break separation induces higher whiff rates only when the changeup is thrown immediately after a fastball. The 3rd changeup thrown in a row with 2 strikes has the highest whiff rate compared to the 1st or 2nd changeup.

Metric	Results
Velocity	Most successful changeups have > 9 mph differential
Vertical Break	For changeups preceded by fastball: Increased vertical break proportion → increased whiff rate
Pitch Sequencing	2nd changeup: lowest exit velocity 3rd changeup: highest whiff rate

Literature cited

1. Allen, Dave. “Optimal Fastball-Changeup Speed Separation.” The Baseball Analysts. May 22, 2009.
2. Hale, Jonathan. “Inside the change-up.” Fangraphs. May 28, 2009.
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4. Dhakar, L. Baseball pitches illustrated. Retrieved from https://lokeshdhakar.com/baseball-pitches-illustrated/

Acknowledgments

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Further information

Please contact tvillahermosa@ucsb.edu for a copy of the full report and more information.