RELIABILITY OF A NOVEL METHOD FOR EVALUATING AND PREDICTING BASE STEALING PERFORMANCE

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INTRODUCTION: Base stealing is considered an important offensive skill in Major League Baseball (Loughin and Bargen, 2008). Managers, coaches, and scouts acknowledge that running speed is an important factor in the game's outcome (Coleman and Amonette, 2014). However, successful base stealing not only requires adequate running speed, but also sufficient perceptual skills in order to begin running when a pitcher commits himself to a pitch. Successful acquisition and processing of visual information about a pitcher's motion is required for a base runner to achieve optimal reaction time and successfully steal the base (Kato, 2007).

Though speed plays a role in base stealing, a base runner's performance is also dependent on his reaction time (Dan Iulian, 2012). Previous research suggests that reaction time is directly proportional to the task complexity, a concept also known as Hick's Law. The more complex a task is, the slower the reaction time will be (Mickevičienė et al., 2008). Base stealing can be classified as a complex task dependent on the motions of the pitcher. A pitcher can work toward preventing a stolen base by throwing over to an occupied base, by delivering the pitch more quickly, or by being deceptive with his motion (Loughin and Bargen, 2008). Thus, reaction time may vary depending on how the runner processes perceptual information from the pitcher.

There seems to be a lack of evidence providing justification that reaction time is a key aspect to successful base stealing. Additionally, the methods of monitoring base stealing performance have traditionally been somewhat rudimentary in the baseball world. On most occasions, coaches and scouts use hand-held timing devices to determine how fast a runner is on the base paths. However, this approach does not allow a coach or scout to evaluate the reaction time of the athlete. Therefore, the purpose of this study was to determine the within session reliability of a novel method for monitoring and evaluating base stealing performance that includes a measure of reaction time. A secondary purpose was to compare electronic and coaches' hand-held timing values for base stealing.

METHODS: Subjects in this study consisted of twenty-five healthy NCAA Division III collegiate baseball players from ages 18-23. Prior to activity, all subjects read and signed informed consent documents approved by the LaGrange College Institutional Review Board.

All data collection for this study was completed on the same day. Subjects completed a standardized warm-up, which consisted of dynamic and static stretches focusing on all muscle groups. Following the warm-up, subjects completed a more specialized warm-up practicing their base stealing technique at 50% and 75% of perceived maximal effort.

Evaluation of base stealing performance was completed via electronic infrared timing gates (Brower Timing Systems, Draper, UT). In order to evaluate reaction time, a touch pad was placed under the pitcher's lead foot. Timing started as the pitcher lifted his foot off of the touch pad. The first set of timing gates was placed directly next to the base runner and the final gate was placed even with the front border of second base. The lead off for the base runners was standardized at 12 feet. When the runner traveled through the first gate, the time recorded was defined as the reaction time (time from pitcher lifting foot off of touch pad to runner passing through the first gate). When the runner traveled through the final gate by sliding into second base, the overall time was recorded. To enhance the ecological validity of the test, the pitchers in the study were directed implement pick-off moves as if they were in a live game. Therefore, the runners were forced to react to the pitcher as they would in a real game. If a base runner was picked off the test was stopped and then repeated. All subjects performed two trials with a right and left-handed throwing pitcher for a total of four trials. The times from trial 1 and trial 2 for each pitcher type were analyzed to determine the within session reliability.

Simultaneous to the timing gate data collection, two-baseball coaches collected and recorded base stealing times via hand-held stopwatches (Accusplit Survivor, Pleasanton, CA). In an effort to evaluate potential human error associated with the hand-held stopwatch method, the times collected by the coaches' hand-held stopwatches were compared to the infrared timing gate system times.

All statistical analyses were completed using SPSS version 17.0 (IBM, New York, NY, USA). Reliability was determined with intraclass correlation coefficients (ICC) and coefficients of variation (CV) to construct relative and absolute measures of reliability. Comparisons between coaches' hand-held stopwatch times and electronic timing gate times were completed with independent samples *t* tests. In an effort to protect against Type I error, a Bonferroni correction was applied as multiple *t* tests were conducted. Thus, the statistical significance was set at 0.025. Additionally, Cohen's *d* effect sizes were determined to provide effect size estimates and were interpreted using the scale provided by Hopkins (2014). Briefly, Hopkins describes an effect size of 0.0-0.19 as trivial, 0.2-0.59 as small, 0.6-1.19 as moderate, 1.2-1.99 as large and beyond 2.0 as very large.

RESULTS: Data from the reliability analysis and descriptive statistics of the novel assessment technique are shown in Table 1. While good relative reliability was found in RT (Reaction Time) and FT (Full Time), absolute reliability measures were elevated in RT. Statistically significant differences were found between FT and CT (Coach's Time) with large effect size estimates (right $p < 0.001$ $d = 1.28$ and left $p < 0.001$ $d = 1.49$).

Table 1. Results from reliability analysis and descriptive statistics of the electronic timing gate base running assessment method

	Right Handed Pitcher	Left Handed Pitcher
ICC RT	0.74	0.84
ICC FT	0.84	0.75
CV RT	32.30	35.52
CV FT	4.37	4.82
Average RT	0.34 ± 0.11	0.39 ± 0.11
Average FT	3.98 ± 0.19	4.08 ± 0.19

ICC=Intraclass Correlation Coefficient, CV= Coefficient of Variation, RT= Reaction Time, FT= Full Time

DISCUSSION: The primary purpose of this investigation was to determine the within session reliability of a novel method for evaluating base stealing performance. The primary finding of this study was that subjects maintained their position within the group over repeated measurements in RT and FT, creating good relative reliability. Some of the RT's varied for each subject, so the absolute reliability measure for RT was elevated. While elevated CVs are due to increased variability, this may also indicate increased measurement sensitivity. This increased sensitivity may be a marginal difference, but it may be large enough to determine the success of a base stealing performance. However, further research would be required to validate this notion.

A secondary purpose of this investigation was to compare the times collected from the coaches' hand-held stopwatches to those of the novel method. As stated previously, RT has been indicated as a factor that may influence base stealing performance. Unfortunately, the traditional method does not measure RT, only FT. The data showed that there were statistical differences found between FT and CT with large effect size estimates. The large statistical difference between CT and FT could be due to error in measurement of the traditional CT method and/or increased measurement sensitivity of the novel method. Further research into inter-rater reliability of CT could rule out potential error due to tester variability. Also, validating both methods using high-speed cameras could provide insight into measurement error from both methods.

Based on the results of this investigation, the novel method for determining base stealing is recommended along with or in substitution for the traditional method. This recommendation is primarily

based on the increased sensitivity of the novel method and because the novel method gives an additional variable of value (RT). Furthermore, the information given by the novel technique in the current investigation may aid scouts or coaches in predicting base stealing success and overall performance in baseball players.

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