

Testing Pitch Recognition to Improve Talent Identification and Player Development

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Abstract

The goal of this paper is to investigate the usefulness of video-occlusion testing of batters' *pitch recognition* skills in professional baseball organizations. A highly valued perceptual attribute of modern batters, pitch recognition can be measured without batters amassing hundreds of plate appearances. Pitch Recognition testing, triangulated with analytics, can improve player evaluation, development, and even opponent preparation at the major league level. This paper merges decades of sport science research using video-occlusion methods with recent "micro-studies" applying video-occlusion testing of pitch recognition in minor league baseball, college baseball, and the Cape Cod Baseball League in order to address issues germane to the field testing that widespread implementation requires.

Introduction

Convenient and valid testing of baseball batters' pitch recognition ability can have substantial value to professional baseball organizations for talent identification and player development. Scouts can measure a prospect's chances of eventually hitting major league pitching. Player personnel directors can more accurately determine when a player is ready for advancement or verify that a batter sent to winter ball to "work on his pitch recognition" has, in fact, improved. Coaches can identify and remediate batters' specific pitch recognition weaknesses. Major league managers can determine how batters "see" particular pitchers and adjust the batting order or select pinch hitters accordingly. In all of these situations, testing batters' pitch recognition skill offers baseball analysts predictive data to triangulate with descriptive batting performance measures.

Although computer applications (e.g., *Neuroscouting*) and portable EEG (e.g., *de Cervo*) have garnered press attention and interest from major league baseball organizations [1], these innovative methods of testing pitch recognition have yet to be validated in peer-reviewed expert-novice studies. The *temporal occlusion* method, by contrast, has been validated through 30 years of sport science research and been used in applied studies, such as those presented in this paper, that accumulate field evidence in order to refine the design and delivery of occlusion-based testing.



Figure 1. Video-occlusion testing of full-season "A" minor league players.

Temporal Occlusion Testing of Perceptual-Cognitive Sport Skills

Temporal occlusion involves cutting off video playback of an opponent's actions and requiring the viewer to predict the outcome based on recognizing cues in the opponent's action or early ball flight. Sport scientists have used the temporal occlusion method to study ballistically reactive skills such as return-of-serve in tennis, blocking penalty shots in hockey and soccer, and batting in cricket and baseball. These *perceptual-cognitive* skills emphasize visual perception but are differentiated from vision attributes such as dynamic tracking, visual acuity, and peripheral vision. Temporal occlusion using video is called *video-occlusion* and is considered to be a non-interactive simulation because viewers respond to a video image with a prediction or decision but do not respond with a full psychomotor action that an interactive simulation would then respond to [2].

Research on video-occlusion testing and training

Sport scientists usually use video-occlusion in *expert-novice* studies designed to reveal expert performers' use of advance cues. A typical expert-novice video-occlusion study of baseball pitch recognition by Paull and Glencross [3] compared 30 players in the unaffiliated Western Australia Baseball League who were separated into two groups based on experience and batting statistics. The more-skilled ("expert") batters were superior to the less-skilled ("novice") batters at differentiating fastballs from curveballs when viewing video pitches that were occluded at different points before, at, and after Moment of Release (MOR) of a pitch. Expert-novice studies establish discriminant validity, which can be considered the first level of validity.

Sport scientists have further validated video-occlusion by using it as a training method. Indeed, Fadde [4] conducted video-occlusion pitch recognition training that used occlusion points and video clips of pitchers similar to what Paull and Glencross [3] had used in the research lab. The training involved ten 15-minute video-occlusion training sessions (see Figure 2). Half of the batters on a cooperating college baseball team received pitch recognition training and the other half did not. Batters who received training ranked higher in batting average (significant at $p < .05$), on-base percentage, and slugging percentage. The effective use of video-occlusion to train pitch recognition also

reinforces video-occlusion as an appropriate way to test pitch recognition.



Figure 2. Video-occlusion testing in laboratory

Testing of college baseball players' pitch recognition skill has also been conducted using the *Axon Sports* Baseball Hitting Assessment Tool that delivers video-occlusion testing on a computer system [5]. All of the players on a cooperating team individually completed a 20-minute video-occlusion test in which they identified the type (Fastball, Curveball, Changeup, Slider) of 162 pitches from three different pitchers that were occluded at or after the pitcher released the pitch. Coaches on the cooperating team rated all 23 batters' hitting ability. The top-rated batters ($n=5$) were considered "experts" and compared to the rest of the batters ($n=18$). The top group scored significantly higher at all occlusion points, confirming earlier expert-novice studies.



Moore and Müller increased the skill level of batters from college to professional by testing the pitch recognition skill of Australian Baseball League (ABL) batters using a video-occlusion test that featured occlusion points *before* release of the pitch. The researchers designated three experimental groups: Expert (ABL batters with major league, Triple-A or Double-A experience), Near-Expert (ABL batters with Single-A or lower experience or ABL only), and Novice (non-professionals). Expert batters identified the type of pitch being delivered more successfully than near-expert batters at all occlusion points. Differences between experts and near-experts were not statistically significant but differences between near-experts and novices were [6].

From Group Differences to Individual Differences

Expert-novice studies have served an important role in validating pitch recognition as a distinguishing characteristic of baseball batting expertise. However, differentiating groups of expert and novice batters has little applied value for baseball decision makers. In order to provide the type of data that baseball teams could use for talent identification or player development, Müller and Fadde [7] tested 34 minor league players in a cooperating major league organization and then correlated players' Pitch Recognition (PR) scores with batting statistics produced in the full season that followed PR testing. Correlation of PR scores with batting statistics works toward *predictive validity* that is much more difficult, and more valuable, than discriminant expert-novice validity.

Overall PR score and PR score at each occlusion point (Moment-of-Release and two pre-release points) were correlated with basic hitting statistics of Batting Average, On-Base Percentage, and Slugging Percentage as well as statistics associated with pitch recognition or plate discipline: Walk Rate, Strikeout Rate, and Walk-to-Strikeout Ratio. Pearson correlation showed a significant correlation of batters' PR Scores at the earliest pre-release occlusion point the batters' Walk Rates. Other correlations were not significant. A secondary analysis looked only at Fastball-Changeup identification and significant correlations were found between batters' PR Scores at Moment-of-Release and batters' statistics for Walk Rate and On-Base Percentage [7].

Müller and Fadde [7] was the first published attempt to correlate Pitch Recognition scores on a video-occlusion test with full-season batting statistics, which obviously has high practical value for talent identification and player development. A follow-up study of 125 minor league batters tested in spring training 2015 (currently under journal review) analyzed the same correlations between PR scores and batting statistics. Correlation of a pitch recognition test score with batting statistics was also the research question in the first of five micro-studies that are reported in the remainder of this paper. These micro-studies depended on in-season access to competing baseball players and teams, so tight experimental control was secondary to getting the video-occlusion method of testing pitch recognition implemented in a variety of authentic contexts.

Methods

The micro-studies presented here closely resemble Yin's [8] holistic multiple case design in that each micro-study was completed before the next one was started and new studies built on the findings of earlier ones. The micro-studies are described in chronological order to represent the evolution of in-the-field pitch recognition testing. Each micro-study takes advantages of opportunities provided by teams and coaches and molds these opportunities to address some question of design or implementation of occlusion testing in the field.

Micro-Study #1: CCBL 2012

The first micro-study arose from a 2012 MIT/Sloan Sports Analytics Conference presentation on the emerging science of pitch recognition [9]. A Cape Cod Baseball League (CCBL) manager offered the researcher access to his team and two other CCBL teams were also recruited for a PR testing project. Batters on these three CCBL teams took a 10-minute video-occlusion test using a beta version of *Axon Sports'* computer application. The test consisted of identifying the Pitch Type of pitches cut off so that they showed approximately 20 feet of ball flight.

Across the three cooperating teams 24 batters who were tested also had a minimum of 100 plate appearances to analyze. The rank of batters' PR scores was then correlated with the batters' rank among tested batters on a variety of traditional and advanced batting statistics posted on the CCBL website. Players' within-group rank on CCBL statistics were also correlated with their within-group rank on batting statistics from the players' preceding college season. Batting statistics for all 24 players were collected from their college athletic department websites. College statistics were not adjusted for level of competition (e.g., NCAA Division I versus Division III) before ranking batters.

Micro-Study #2: CCBL 2014

A recognized weakness of pitch recognition testing was that it usually included only Pitch Type with no provision for Pitch Location [7]. The primary goal of micro-study #2, therefore, was to have batters predict Ball/Strike location in addition to identifying the type of pitch being delivered. The concern was that predicting Pitch Location might confuse batters and negatively effect the Pitch Type identification that is considered the base-level dimension of pitch recognition.

Batters on two CCBL teams ($n=25$) volunteered for video-occlusion testing. The video test included 48 pitches (3 Pitch Types x 4 occlusion points x 2 ball/strike x 2 repeats) occluded at MOR, two points after MOR, and No Occlusion. The 48-pitch, eight-minute, test was repeated immediately with players switching between marking a paper answer sheet with only Pitch Type and an answer sheet with "B" (ball) and "S" (strike) under Pitch Type so that players could answer both Type and Location by marking one circle (see Figure 3). In a cross-treatment design, one CCBL team took the Type Only test first, followed by the Type + Location

(Ball/Strike) test; the other CCBL team took the same tests but in the reverse order.

Trial Number	Type of pitch? Ball or Strike?		
	Fastball	Curveball	Changeup
1	B S	B S	B S
2	B S	B S	B S
3	B S	B S	B S
4	B S	B S	B S

Figure 3. Test booklet with Ball/Strike added to Pitch Type

Micro-Study #3: CCBL 2015

Micro-Study #4: College baseball – 2 teams

Micro-Study #5: Minor league team

The final three micro-studies used a revised version of the video-occlusion test used by Müller and Fadde [7]. The new test featured two pitchers (left-handed and right-handed) and used occlusion points after pitch release rather than before Moment-of-Release. The minor league testing project provided a database of highly skilled batters that was large enough ($n=125$) to norm distributions of pitch recognition scores.

Micro-studies #3, 4, and 5 used the normed standards and the new video-occlusion test (see Figure 4) to test 34 players from three CCBL teams (#3), 30 college players from two cooperating teams (#4), and 15 players on a full-season “A” minor league baseball team (#5). Micro-study #3 focused on between-group comparison of CCBL players with other college players and professional players. Micro-study #4 compared two college teams, and the PR scores will also serve as the pre/post-test for the teams since they are undertaking pitch recognition training programs. Individual batters’ scores are being used by both teams’ hitting coaches to diagnose and remediate individual batters’ pitch recognition deficiencies. Micro-study #5 was conducted with an affiliated minor league team and focused on individual players’ PR scores. Study #5 was primarily designed to demonstrate uses of pitch recognition testing for player development in the cooperating major league organization.



Figure 4. Screenshot from video-occlusion test.

Three dimensions of pitch recognition were tested and scored: Pitch Type, Pitch Location, and Type-Plus-Location. Each dimension has a different scale since random chance for Pitch Type (Fastball, Curveball, Changeup) is 33%, for Pitch Location (ball/strike) is 50%, and for Type-Plus-Location (both correct) is 17%. To facilitate interpretation, PR scores were aligned to a common scale similar to the familiar 20-80 scouts’ grading scale. The scores are arbitrary and do not represent percent of correct responses on the various PR dimensions. Scores of 60 on any of the PR dimensions represent the mean score of minor league batters tested. Scores over 65 are in the top 25% of test takers while scores of less than 56 are in the bottom 25%. Micro-studies #3, 4, and 5 use the new video test and scaled scores in a variety of contexts.

Results and Discussion

The progression of micro-studies addresses several aspects of designing, administering, and interpreting video-occlusion pitch recognition testing in the field. Table 1 summarizes the key

findings of the micro-studies. Working in the holistic multiple case design framework [8] each micro-study builds on the findings of previous micro-studies.

Table 1. Summary of micro-study findings.

<i>Micro-Study</i>	<i>Key Finding</i>
#1 – CCBL 2012	Correlation of Pitch Type Score to Walk-Rate (only correlation)
#2 – CCBL 2014	Ball/Strike not effect Pitch Type; no retest learning effect
#3 – CCBL 2015	CCBL batters’ slightly better Plate Discipline (Type+Location)
#4 – College teams	PR scores can serve as pre/post-tests of PR training programs
#5 – Minor league (A)	PR scores can inform player development decisions and coaching

Micro-Study #1 correlated CCBL batters’ rank on a Pitch Type test with the batters’ ranks (among tested players) on various batting statistics in the even playing field of the Cape Cod Baseball League. Using the Mann-Whitney *U*-Test of rank correlation scaled for small *n* showed PR score significantly correlated with Walk Rate but no other batting statistics. A secondary analysis correlated batters’ rank on CCBL batting statistics with the batters’ rank (among tested CCBL players) on the same statistics from their pre-CCBL college season. This analysis also showed Walk Rate as the most highly correlated statistic, followed by Strikeout Rate and Walk-to-Strikeout Ratio.

Micro-study #2 produced several findings of value in administering video-occlusion tests, especially in the context of player development where repeated measures are valuable. As shown in Table 2, the study demonstrated that having batters predict Ball or Strike in addition to identifying Pitch Type did not interfere with the base pitch recognition dimension of Pitch Type. In addition, back-to-back administration of exactly the same video test showed that no learning effect was introduced, which has important implications for using the same video-occlusion test for repeated measures. Team Two took the Type Only test first, followed by the Type+Location version; Team One reversed the order. Scores are percent of correct pitch type identification.

Table 2. CCBL repeated test: Pitch Type vs. Pitch Type + Location (Ball/Strike).

	<i>First Test</i>	<i>Second Test</i>	<i>Type Only</i>	<i>Type+Location</i>
Team One	82%	81%	81%	82%
Team Two	81%	80%	81%	80%

Table 3 shows between-group comparisons among the college and professional batters tested in *micro-studies #3, #4, and #5*. Because most of the players on these teams are mid- to high-skilled batters, there are not substantial differences between the mean scores of batters in each group. These scores indicate that CCBL, college Team One, and low-A minor league batters had better plate discipline, represented by Location and Type+Location scores. The scores are not percent correct but rather an arbitrary score similar to the 20-80 scout grading scale.

Table 3. Mean scores adjusted to “60” standard.

<i>Level</i>	<i>Type</i>	<i>Location</i>	<i>Type + Location</i>
NORM (MiLB)	60	60	60
CCBL 15	61 (sd = 4.7)	63 (sd=4.7)	63 (sd=4.9)
College 1	60 (sd=6.0)	63 (sd=6.4)	63 (sd=5.6)
College 2	60 (sd=5.0)	60 (sd=5.1)	59 (sd=2.8)
Full-Season “A”	58 (sd=5.8)	64 (sd=6.1)	62 (sd=6.1)



Micro-study #4 tested two college teams in fall 2015. As shown in Table 3, the teams had equal mean *Pitch Type* scores. Team One had a higher mean *Location* score ($p=0.17$; not significant) and *Type+Location* score ($p=0.02$; significant at $p<.05$). *Type+Location*, which involves getting both Type and Location (ball/strike) correct, is hypothesized to represent Plate Discipline. Team 1 had participated in a pitch recognition training program [10] for two seasons prior to the test and is continuing training into the 2016 season. Team 2 will undergo pitch recognition training prior to the 2016 season. For both teams, testing in fall 2015 serves as a pre-test with the same video-occlusion test to be administered in spring 2016 as a post-test to measure effects of pitch recognition training on both team and individual batters’ performance.

Micro-study #5 demonstrated pitch recognition testing for player evaluation and development in a professional baseball organization. Table 4 displays PR scores of four of the 15 players tested on an affiliated full-season A-level team. Some players tested in May and some July; two players tested both times. Comments that follow relate PR scores to player performance as judged qualitatively rather than correlated to specific batting statistics.

Table 4. Full-Season “A” Pitch Recognition Test by Percentile (sample).

	Pitch Type	Pitch Location	Type+Location
Robert	58	69	66
Thomas	64	71	72
Lorenzo	53	52	54
Jorge	47	62	49

Robert established a high on-base percentage early in in the low-A season and was quickly promoted. He continued to draw walks but his batting average fell at the high-A level. His profile is one of good plate discipline, but not necessarily basic pitch recognition.

Thomas was a second-round draft pick because of his high on-base skills in college and continued to show good plate discipline as a professional (13% career Walk Rate) but with a low batting average (career .227). Coaches were retooling his swing and he struggled throughout the low-A season. The team manager shared his PR scores with Thomas as evidence that his “eye” was still superior and that, when the swing adjustments were mastered, his production should increase dramatically.

Lorenzo scored in the bottom 25% on all three PR dimensions yet was a productive leadoff hitter. He retested in July and scored almost exactly the same scores. Lorenzo demonstrates that some batters can be successful without high pitch recognition. He had a flat, quick swing and could put many balls in play. He shows the need for organization equivalents to see if his PR skills can play up.

Jorge was a productive, middle of the order hitter and first-half all-star but suffered a severe second-half drop-off. He was promoted to high-A but struggled and returned to low-A. Jorge would be a good candidate for concentrated PR training to match his 5-tool profile.

The use of PR scores to inform player development is optimized when all players receive baseline testing so that batters can be retested for changes in pitch recognition skill before making changes in batters’ mechanics or approach. Use of PR scores for player development purposes are likely to differ between organizations, but having consistent and valid testing supports a focus on pitch recognition and plate discipline that is valued in many organizations.

Conclusion

Video-occlusion testing of pitch recognition as a perceptual-cognitive sub-skill of baseball batting has been validated through 30 years of sport science research. Supplemented by the micro-studies reported here video-occlusion testing is now feasible for wide-spread use in professional baseball organizations, with benefits for talent identification and player development. The greatest benefits will come with baseline testing during spring training, including players on the 40-man roster. Organizations (and scientists) need to know if and to what degree the highest-level performers are differentiated by superior pitch recognition. As team analysts track changes in batters' PR scores through levels of development they have another tool to predict next-level performance. PR testing on a laptop or tablet computer can also be used to assess prospects, even at early ages or in sub-optimal or poorly documented levels of competition.

Despite video-occlusion being a technologically simple format (compared to virtual reality or EEG), video-occlusion tests must be carefully constructed with consideration of camera angles and occlusion points. Testing protocols also need to be consistently applied within and between organizations to maximize comparing test results. Ideally, the same established and validated pitch recognition tests should be used by different teams and levels (college and professional) to add data points and strengthen test reliability.

Although it is not the focus of this paper, pitch recognition testing folds naturally into pitch recognition training programs using not only video but also "live" occlusion with occlusion goggles [11] and adapted batting drills [10]. Video-occlusion testing can also serve as a dependent variable to assess the effects of vision training programs or other initiatives. Ultimately, team analysts can triangulate pitch recognition scores along with batting performance data to improve talent identification and player development.

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