Modeling Ability and Decision Difficulty Among Expert Baseball Umpires

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ABSTRACT

In baseball, home plate umpires' perceptual-cognitive skills are tested with each pitch as they are required to judge, with accuracy, whether the ball passed through the imaginary region above home plate known as the strike zone. Home plate umpires must visually track the flight of a pitched ball as it leaves the pitcher's hand and travels over the home plate region to accurately determine whether a pitch should be called a strike or a ball. Among other variables influencing umpire decision making ability, the location of the pitch is of particular importance as pitchers routinely work to avoid the regions nearest home plate while favoring peripheral regions.

Using a Rasch model, I estimated expert baseball umpires' ball/strike decision making ability and difficulty over the course of the 2015-2017 regular and postseasons. Pitch location was operationalized as a test item residing in one of 16 regions in and around the strike zone area (see Fig. 1).

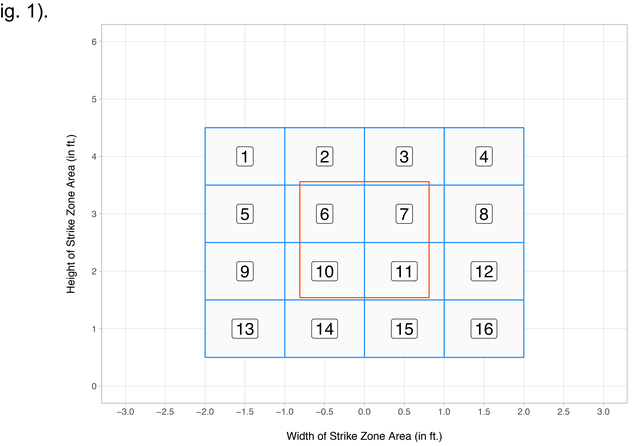

Fig. 1. Pitch location regions. Red outline represents strike zone.

METHOD

Data for the current study were collected using the **`pitchRx`** package (Sievert, 2014) in the **R** statistical computing software application (R Core Team, 2018) representing all pitches delivered over the course of the 2015 – 2017 regular and post-seasons.

Data for the current study are generated by a camera system, known as *PITCHf/x* (Sportvision, Inc., 2013), installed inside each MLB team's stadium for the purpose of capturing and measuring the flight path of pitched baseball trajectories (Nathan, 2008; Sievert, 2014). *PITCHf/x* data consist of all pitch-outcome decisions made by home plate umpires over the course of a single season.

Using a Rasch model, we estimated expert baseball umpires' ball/strike decision making ability and difficulty over the course of the 2015-2017 regular and postseasons. Pitch location was operationalized as a test item residing in one of 16 regions in or around the strike zone area.

Three Rasch models were estimated: 1) all batters, regardless of handedness; 2) right-handed batters; and 3) left-handed batters. In addition to item difficulty parameters, predicted probabilities of umpire decision accuracy were obtained for each of the 16 pitch location regions. In addition to umpire ability parameters, differences between umpire decision accuracy for right- and left-handed batters will be presented.

Table 1

Rasch Model Fit Statistics of MLB Strike Zone Region Difficulty and Probability of Umpires' Correct Decision Across Right- and Left-Handed Batters, 2015 – 2017

Region	Difficulty	Probability	Δ
10	-1.49	0.816	-0.121
11	-1.60	0.831	-0.106
6	-1.63	0.836	-0.102
7	-1.67	0.842	-0.095
9	-2.31	0.910	-0.027
5	-2.93	0.949	0.012
2	-3.11	0.957	0.020
3	-3.20	0.961	0.023
15	-3.22	0.962	0.024
12	-3.37	0.967	0.029
8	-3.62	0.974	0.037
13	-5.52	0.996	0.059
14	-7.10	0.999	0.062
1	-7.28	0.999	0.062
16	-7.39	0.999	0.062
4	-8.20	1.000	0.062

Note. Δ = Difference between probability of an umpire with median ability making a correct decision in that region and the mean probability across all regions.

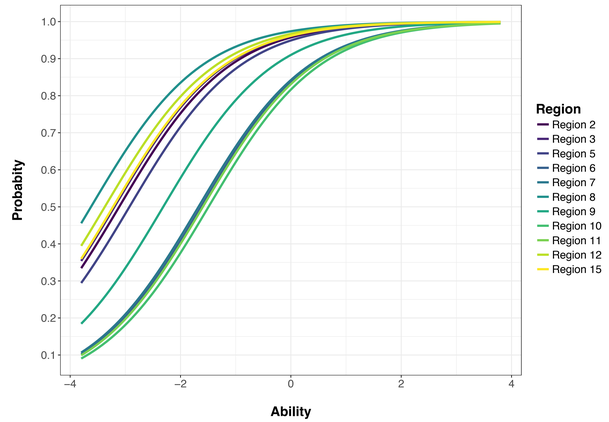

Fig. 2. Item characteristic curves for Model 1, across right- and left-handed batters, 2015 – 2017.

Table 2

Rasch Model Fit Statistics of MLB Strike Zone Region Difficulty and Probability of Umpires' Correct Decision by Batter Handedness, 2015 – 2017

RHB				LHB			
Region	Difficulty	Probability	Δ	Region	Difficulty	Probability	Δ
10	-1.36	0.795	-0.137	10	-1.49	0.816	-0.121
6	-1.43	0.806	-0.126	11	-1.60	0.831	-0.106
11	-1.65	0.838	-0.094	6	-1.63	0.836	-0.102
7	-1.68	0.842	-0.090	7	-1.67	0.842	-0.095
9	-2.08	0.889	-0.044	9	-2.31	0.910	-0.027
14	-2.68	0.936	0.003	5	-2.93	0.949	0.012
5	-2.75	0.940	0.007	2	-3.11	0.957	0.020
2	-3.19	0.960	0.028	3	-3.20	0.961	0.023
3	-3.29	0.964	0.032	15	-3.22	0.962	0.024
15	-3.58	0.973	0.040	12	-3.37	0.967	0.029
12	-4.70	0.991	0.058	8	-3.62	0.974	0.037
8	-4.82	0.992	0.059	13	-5.52	0.996	0.059
13	-5.26	0.995	0.062	14	-7.10	0.999	0.062
1	-7.28	0.999	0.067	1	-7.28	0.999	0.062
4	-8.19	1.000	0.067	16	-7.39	0.999	0.062
16	-9.58	1.000	0.067	4	-8.20	1.000	0.062

Note. RHB = Right-handed batter; LHB = Left-handed batter; Δ = Difference between probability of an umpire with median ability making a correct decision in that region and the mean probability across all regions.

RESULTS

A total of 1,623,765 pitches were delivered to batters during the course of the 2015 – 2017 regular and post-seasons. Umpires were required to make a total of 675,364 decisions, of which 248,079 (37%) were called strikes and 427,285 (63%) were called balls. On average, home plate umpires made decisions on approximately 149 pitches per game (SD = 5.89).

Three, one-parameter Rasch models were estimated in order to model MLB home plate umpire decision difficulty. Model 1 estimated umpire decision difficulty across each of 16 strike zone regions for both right- and left-handed batters (see Table 1). Models 2 and 3 estimated umpire decision difficulty across each of 16 strike zone regions for right- and left-handed batters, respectively (see Table 2).

In all three models, varying combinations of regions 6, 7, 10, and 11 resulted in greater difficulty measures, relative to the other 12 regions. Corresponding probability estimates are reported, which indicate the predicted rate at which an umpire with median ability will make a correct decision when a pitch is thrown in each region of the strike zone (see Tables 1-2).

Item characteristic curves (ICCs) for Model 1 are presented in Fig. 3. For the purposes of visualizing the ICCs, regions 1, 4, 13, 14, and 16 were removed as they were not highly discriminable. For the sake of brevity, only ICCs from Model 1 are presented. Finally, mean accuracy rates for all MLB home plate umpires who made ≥ 5,000 decisions between 2015 – 2017 are presented in Fig. 3.

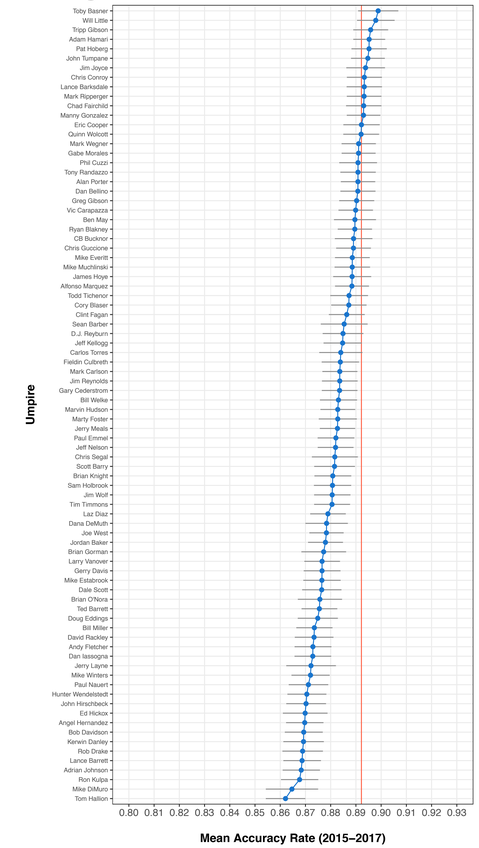

Fig. 3. Mean accuracy rates of individual umpires with > 5000 decisions, 2015 - 2017.

Data and R Code:
http://bit.ly/aps-2018

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