COGNITION

Major League Baseball

How All-Stars Players are Wired Differently

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2023 MLB All-Stars

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Key Findings

Compared to major league Everyday Starters, 2023 MLB All-Stars show,

- <u>Greater Offensive Production</u> - Significantly higher major league SLG and OPS.

- <u>Bigger Impact</u> - Significantly higher ISO, Hard Hit%, and Max Exit Velo.

- <u>Higher Cognitive Capacity</u> - Significantly higher S2 Timing Control, Distraction Control, Impulse Control, and Instinctive Learning.

Much of what makes Major League Baseball's annual All-Star Game special is that it showcases the best of the best and offers compelling matchups between the game's premier pitchers and elite hitters. Players taking the field for the All-Star Game possess "*separator*" tools and talent, an industry term describing capabilities that separate them even against other accomplished professionals. Separator tools are associated with individual differences in on-field performance which often stand out when observed and are well-defined by a host of metrics. After all, differences in performance are largely why they are All-Stars. At S2 Cognition we've focused on cognitive functions underlying some of these tools (e.g., hit, power). More specifically we've been interested in whether cognitive functioning is part of what separates the best from the rest. That said, some essential knowledge gaps remain regarding whether the league's elite hitters have separator cognitive capacity relative to everyday starters and reserves. The recent 2023 All-Star break presented an opportunity to address a primary question:

> Does cognitive capacity, as measured by S2, separate All-Stars from Everyday Starters and Reserves?
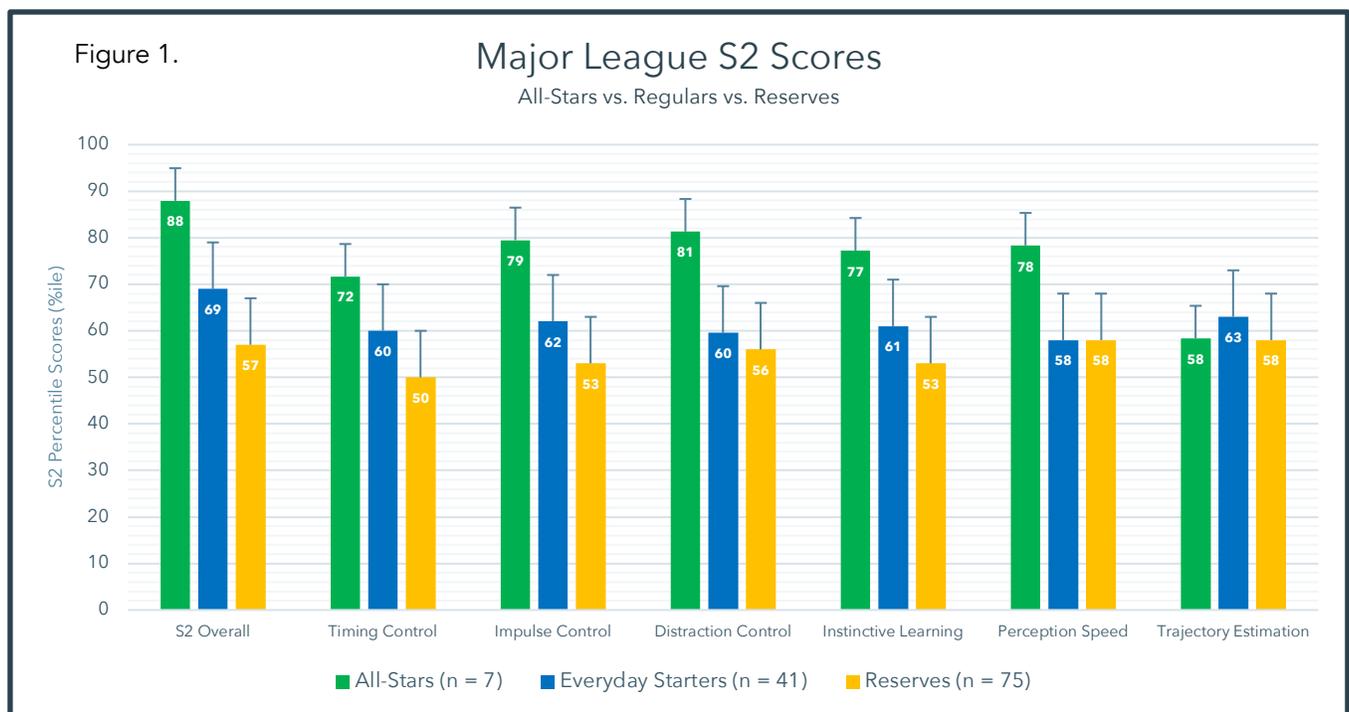
S2 Cognition's baseball assessment battery measures speed and accuracy of visual information processing, as well as complex attention and decision making at game speed. The battery comprises tests of perception speed, tracking non-linear movement, timing, impulse control, and pattern recognition, all specialized functions mediated by the brain, all measured with millisecond temporal resolution. Each of these tasks also makes demands near

the far end of how quickly and accurately the human brain can make decisions. As such, S2 scores are best understood as indicators of *cognitive capacity* to compete at the highest level.

In two previous papers we examined MLB hitter perception speed (*Looking for Guys Who See Fast*), as well as instinctive learning (*Won't Get Fooled Again*) and their relationship to major league hitting. In this paper we studied differences in cognitive capacity and on-field performance of between all-stars and everyday position players for the 2023 season. We looked specifically at players who the industry collectively decided were the best players, and then analyzed available S2 scores for that select group. The following 2023 All-Stars had S2 evaluations that were included in the analysis:

> Bo Bichette, INF, Toronto Blue Jays
> Corbin Carroll, OF, Arizona Diamondbacks
> Jonah Heim, C, Texas Rangers
> Josh Jung, INF, Texas Rangers
> Aaron Judge, OF, New York Yankees
> Sean Murphy, C, Atlanta Braves
> Adley Rutschman, C, Baltimore Orioles

Figure 1 below shows average S2 scores for the All-Stars listed above, as well as 41 Everyday MLB Starters and 75 MLB Reserves. Scores are grouped by neurocognitive domains and shown as percentiles (%ile), ranging from 1-100, and an average score of 50. Percentile scores represent the percentage of scores below an individual score. Thus, a score of 75 represents that individual performed better than 75% of other players taking the assessment. S2 percentile scores are based on results normed to over 2,000 professional baseball players and amateur draft prospects.

Figure 1.

Major League S2 Scores
All-Stars vs. Regulars vs. Reserves

Domain	All-Stars	Everyday Starters	Reserves
S2 Overall	88	69	57
Timing Control	72	60	50
Impulse Control	79	62	53
Distraction Control	81	60	56
Instinctive Learning	77	61	53
Perception Speed	78	58	58
Trajectory Estimation	58	63	58

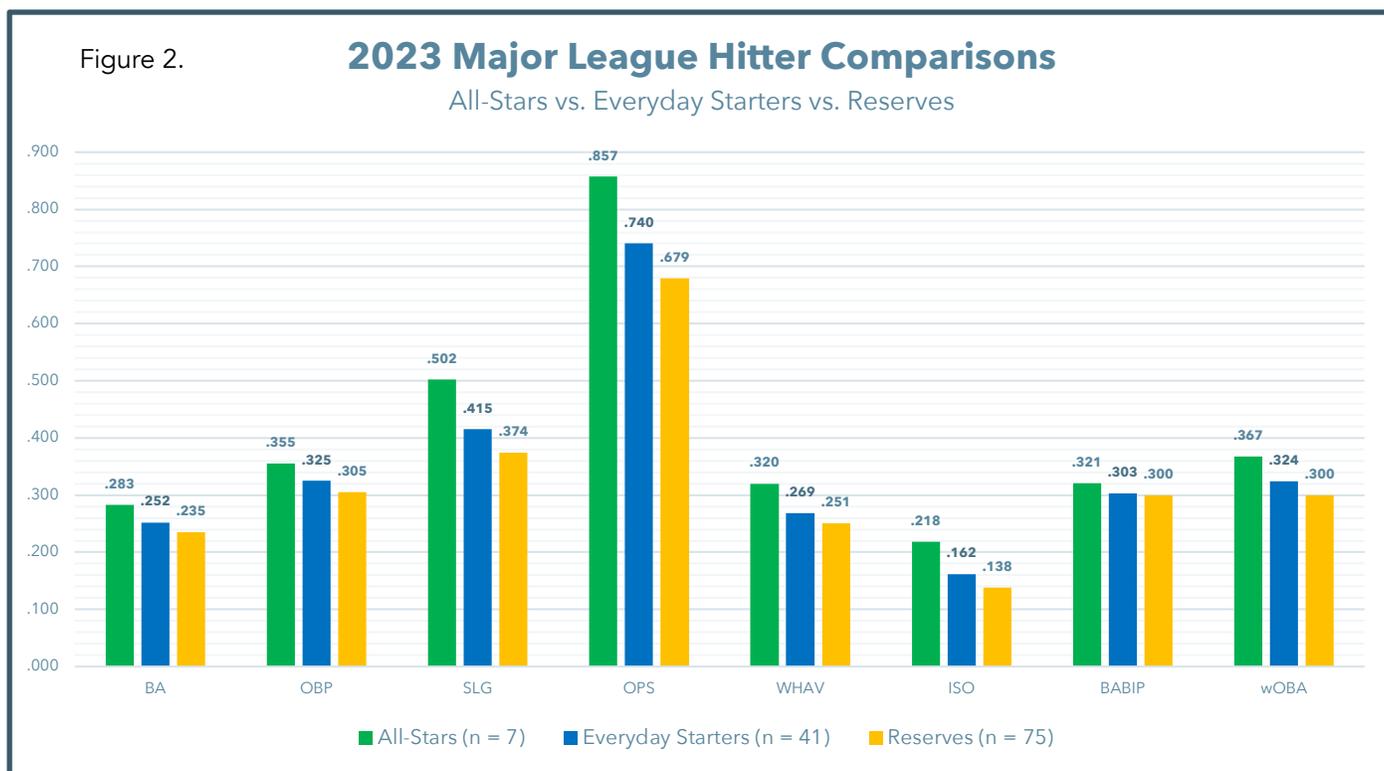All-Stars (n = 7) • Everyday Starters (n = 41) • Reserves (n = 75)

Given the size and scope of differences in cognitive function among players at the highest level, we were curious to know whether there was similar separation in on-field performance. Before examining offensive production metrics, it's worth clarifying where these groups did not differ. Table 1 shows key playing and performance metrics for both major league groups.

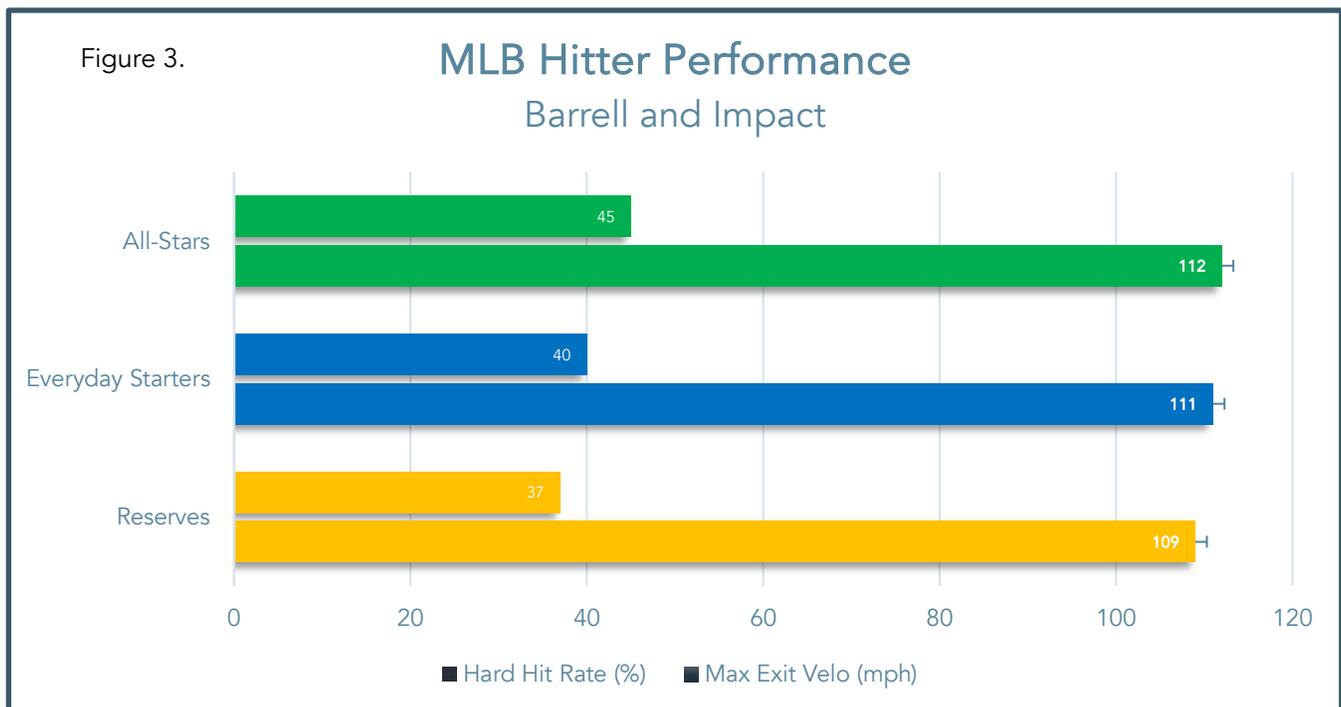| Table 1.	All-Stars	Everyday Starters	
Age	25.6 years	26.1 years	*not different*
Games (G)	95	95	*not different*
Pitches Seen (P)	1612	1492	*not different*
Plate Appearances (PA)	409	382	*not different*
Successful PAs (SPA)	161	138	* different
Contact Rate%	76%	76%	*not different*
Strikeout Rate% (SO%)	22%	22%	*not different*
Walk Rate% (BB%)	10%	9%	*not different*

It's noteworthy that All-Stars and Everyday Starters did not differ in age, games played, or PAs. Moreover, these groups did not differ in Contact Rate%, Strikeout Rate%, or Walk Rate%. The similarities between All-Stars and Everyday Starters is not surprising, however it is in stark contrast to the difference in Successful Plate Appearances (SPA). The fact that All-Stars and Everyday Starters had similar opportunities to hit, as well as similar outcomes for Contact Rate%, Strikeout Rate%, and Walk Rate% makes moderate size differences in offensive production more salient.

Figure 2 below shows offensive production as of August 2023 for MLB All-Star Game starters, everyday MLB position players (PA $\geq$ 3.1/Game), and MLB reserves (exceeded rookie status, and had between 50 - 300 PAs).

Figure 2.

2023 Major League Hitter Comparisons
All-Stars vs. Everyday Starters vs. Reserves

All-Stars (n = 7) Everyday Starters (n = 41) Reserves (n = 75)

Results across multiple offensive metrics are notable for a stairstep pattern, with All-Stars performing best, followed by everyday MLB regulars, and major league reserves. The greatest magnitude of performance difference was OPS (and the metrics it comprises, OBP + SLG), a measure of overall offensive production. Additionally, the All-Star group had significantly higher batting average (BA), well-hit average (WHAV), batting average for balls in play (BABIP), and weighted on-base average (wOBA).

As mentioned in the introduction, it's unsurprising that All-Stars have outperformed all other major league players this season on common metrics of offensive production. Differences in how these groups tend to hit the ball provides additional detail to the observed performance outcomes. Figure 3 below reveals group differences in Max Exit Velocity (mph), as well as rate (%) of balls that were Hard Hit (+95 mph). Results indicate the All-Star group tends to have more consistent quality contact and slightly more raw power. The large differences in isolated power (ISO) are also consonant with indicators of the All-Star group hitting the ball harder and more frequently.

Figure 3.

MLB Hitter Performance
Barrell and Impact

Considered collectively, these results highlight fundamental differences in cognitive capacity among players selected to start the 2023 MLB All-Star game, Everyday Starters, and Reserve Players. The All-Star group outperformed all other major leaguers, and most interestingly, demonstrated higher cognitive capacity on S2's test battery. Moreover, Everyday Starters demonstrated higher cognitive capacity than big league Reserves. The All-Star game showcases the best hitters in the game, and the available sample of S2 assessments indicates they have exceptionally high capacity for processing visual cues associated with pitch recognition, sustaining attention, controlling the impulse to abandon their approach or swing at pitches out of the zone, adjusting to changes in velocity, and discerning patterns in pitch

sequence and delivery. These high-order cognitive abilities clearly confer advantages to better performance and corresponding in-game offensive production metrics.