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# ***GETTING A GRIP ON HITTING***

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*Grip Strength and Batted Ball Velocity as Predictors of  
Slugging Percentage and Isolated Power*

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## INTRODUCTION

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Pictures and videos of power hitters' best swings throughout the ages have quite often showcase ripping forearm muscles. Most spectators pay superficial attention to these sculpted and sometimes Herculean anatomical features, but grip strength is not just important for featured photographs used in the *ESPN The Magazine* Body Issue (1). Where strength and conditioning coaches focus on function, hypertrophy, strength, and power; college recruiting coordinators and professional scouts are concerned with speed and velocity, and front office analysts draw their attention to performance. This article will tie these three components together. Grip strength (GS) and batted ball velocity (BBV) correspond respectively as process and outcome indicators of power potential in baseball hitters as identified by a strong positive correlation to Slugging Percentage (SLG) and Isolated Power (ISO) performance metrics.

## THE DATA: BASEBALL ATHLETIC TESTING SYSTEM, PRE-TEST, POST-TEST AND I-SCORE STATISTICAL COMPARISON

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Participants in this study include 23 of the 158, 18-25 year-old, male, baseball student-athletes that played collegiate summer baseball in the Puget Sound Collegiate League (PSCL) during the 2013 season. Players in the PSCL represent various high schools (in some cases), colleges, and universities across the United States of America. The 23 subjects included in this study were the only athletes to complete all Baseball Athletic Test (BAT) components in both pre-test and post-test events (1).

Participants received no compensation for participation in this study. The PSCL Baseball Combine and its implementation of the BATS pre-test and post-test were a complimentary benefit that accompanied registration fees to participate in the PSCL. Participation in this study was voluntary and participants had the opportunity to decline to participate without penalty.

Any and all risks to participants of this study were inherent to those which are typically associated with normal, everyday, baseball activity. Throwing, catching, running, hitting for average, and hitting for power are considered to be the five tools associated with baseball performance. The BAT presented no additional risk than typical participation in PSCL activities did. Each participant completed a Physical Activity Readiness Questionnaire (PAR-Q) Form, PSCL Waiver, and Research Consent Form prior to participating in any research activity.

Dr. Frank J. Spaniol's (2009) Baseball Athletic Testing System (BATS) should be considered as the industry standard for baseball-specific, quantitative testing (2,3). BATS was used in a pre-test and post-test format to allow comparison of participants scores on the following tests that comprise the test battery: demographics/anthropometrics, body composition, flexibility, muscular strength, power, agility, speed, anaerobic capacity, throwing velocity, and batted-ball velocity (2,3). For this study, athletes warmed-up prior to testing. GS testing utilized the Jamar Plus + Hand Dynamometer with an alternating left-hand right-hand testing protocol with the elbow at 90° of flexion for two attempts on each hand recording each attempt, but using the greatest GS of the four trials for statistical treatment (Table 1). BBV testing utilized the Stalker Sport 2 Digital Sports Radar Gun and a three swing protocol off a batting tee recording all three trials, but using the highest BBV of the three trials for statistical treatment (Table 1).

The pre-test took place the first weekend of the PSCL Season on Sunday, June 2, 2013; and the post-test took place the last weekend of the PSCL Regular Season on Saturday, July 27, 2013 before the PSCL Championship Tournament. Each of the two testing sessions on both pre-test and post-test dates included two of the six PSCL teams, provided each player the opportunity to complete the entire test battery, and lasted approximately two hours. All PSCL Games, all sport-specific player development (PD) activities, and all sport-specific strength and conditioning (S&C) activities were completed between these pre-test and post-test dates.

The BATS pre-test and post-test data was recorded using a paper and pencil record sheet for each individual athlete. The data was entered, statistically treated, and saved within a Microsoft Excel 2013 Spreadsheet. Gains and/or losses between pre-test and post-test scores were points of emphasis in an attempt to identify either a level of improved performance or a level of diminished performance within athlete activity level groupings. A level of improved performance was identified within the gain scores and focused on GS and BBV in this study

(Table 1). The electronic file containing all BATS data, PD, and S&C is stored on an 8GB Gigaware Flash Drive.

As is inherent to the sport of baseball, player game performance was recorded for analysis (Table 2). I-Score Software was used to record player game performance in the PSCL. BATS data was shared with college baseball coaches and/or professional baseball scouts upon request (Table 2). Therefore, PSCL League Administrators, PSCL Coaches, and PSCL Players had access to a centralized hard copy of the BATS results. This centralized hard copy of the BATS results simply lists raw data and was kept in the game operations tent for the league; further distribution (i.e. copies, file shares via email, etc.) of the BATS results will not be allowed. The PSCL is a developmental collegiate summer baseball league that emphasizes teaching and learning, and this practice of sharing information falls in line with the league philosophy. I-Score Software Files were exported to, statistically treated, and saved within a Microsoft Excel 2013 Spreadsheet. The electronic file containing I-Score Season Reports is stored on an 8GB Gigaware Flash Drive.

Only the researchers have access to the statistically treated data in order to keep the results private and confidential. Steps have been taken to randomly assign an identification number to each participant in place of their name for the sake of publication (Table 1,2,3). The data was entered, statistically treated, and saved within a Microsoft Excel 2013 Spreadsheet. Significant correlation between pre-test and post-test scores was the point of emphasis in the original thesis in an attempt to identify either a level of improved performance or a level of diminished performance within athlete activity level groupings (Table 3). Athletes who participated in PD and S&C are bolded within Table 1, Table 2, and Table 3. The electronic file containing all statistically treated BATS data is stored on an 8GB Gigaware Flash Drive.

**Table 1**  
**Process and Outcome Measures**

<i>Participants</i>		<i>Observation 1</i>		<i>Observation 2</i>		<i>Observation 1 &amp; Observation 2</i>	
<i>N = 23</i>		<i>BATS Pre-Testing</i>		<i>BATS Post-Testing</i>		<i>Gain Scores</i>	
		<i>GS (kg)</i>	<i>BBV (mph)</i>	<i>GS (kg)</i>	<i>BBV (mph)</i>	<i>GS (kg)</i>	<i>BBV (mph)</i>
1		47.4	82	53.2	85	5.8	3
2		52.3	85	59.3	88	7.0	3
3		70.4	75	79.4	67	9.0	-8
4		54.1	79	62.2	88	8.1	9
5		54.8	78	62.9	77	8.1	-1
6		42.7	75	50.9	77	8.2	2
7		66.9	86	72.3	84	5.4	-2
8		57.7	80	68.1	86	10.4	6
9		51.2	67	48.4	70	-2.8	3
10		45.7	85	57.1	78	11.4	-7
11		57.3	79	61.9	85	4.6	6
12		67.8	87	74.6	85	6.8	-2
13		57.2	78	67.9	86	10.7	8
14		50.0	76	55.8	73	5.8	-3
15		43.5	64	52.4	69	8.9	5
16		59.1	83	67.9	85	8.8	2
17		49.6	79	64.0	78	14.4	-1
18		45.2	78	46.2	80	1.0	2
19		54.9	92	66.3	86	11.4	-6
20		65.9	90	71.4	91	5.5	1
21		59.5	64	64.5	68	5.0	4
22		55.2	75	53.5	85	-1.7	10
23		51.7	73	53.1	86	1.4	13
<i>totals</i>		<i>GS (kg)</i>	<i>BBV (mph)</i>	<i>GS (kg)</i>	<i>BBV (mph)</i>	<i>GS (kg)</i>	<i>BBV (mph)</i>
<i>N = 23</i>	<i>All Pre-Post</i>	54.8	78.7	61.4	80.7	6.7	2.0
<i>N = 22</i>	<i>PD</i>	52.5	75.0	58.9	76.9	6.4	1.9
<b><i>N = 8</i></b>	<b><i>PD+S&amp;C</i></b>	<b>58.2</b>	<b>80.6</b>	<b>65.9</b>	<b>83.3</b>	<b>7.8</b>	<b>2.6</b>
<i>N = 14</i>	<i>PD-S&amp;C</i>	53.0	77.1	59.0	78.8	6.0	1.6
<i>N = 15</i>	<i>Non S&amp;C</i>	<i>no data</i>					

<b>Table 2</b>									
<b>Performance Measures</b>									
<i>Participants</i> <i>N = 23</i>		<i>Treatment 1</i> <i>PSCL Game Performance</i>							
		<i>GP</i>	<i>PA</i>	<i>RPA</i>	<i>OBP</i>	<i>SLG</i>	<i>OPS</i>	<i>AVG</i>	<i>ISO</i>
1		16	44	0.273	0.419	0.294	0.713	0.265	0.029
2		21	67	0.284	0.433	0.407	0.840	0.296	0.111
3		27	107	0.355	0.402	0.302	0.704	0.256	0.046
4		21	101	0.446	0.505	0.595	1.100	0.367	0.228
5		25	89	0.326	0.393	0.355	0.749	0.289	0.066
6		27	111	0.288	0.369	0.242	0.611	0.231	0.011
7		14	53	0.321	0.396	0.432	0.828	0.273	0.159
8		26	92	0.359	0.420	0.456	0.876	0.265	0.191
9		16	59	0.271	0.220	0.196	0.417	0.179	0.017
10		17	66	0.288	0.424	0.327	0.752	0.309	0.018
11		17	66	0.409	0.500	0.482	0.982	0.411	0.071
12		23	91	0.352	0.429	0.453	0.882	0.320	0.133
13		19	88	0.500	0.500	0.514	1.014	0.389	0.125
14		12	41	0.293	0.341	0.273	0.614	0.182	0.091
15		17	54	0.204	0.296	0.159	0.455	0.136	0.023
16		25	88	0.250	0.420	0.338	0.759	0.231	0.107
17		18	50	0.140	0.220	0.133	0.353	0.133	0.000
18		17	59	0.305	0.441	0.480	0.921	0.340	0.140
19		13	42	0.333	0.293	0.361	0.654	0.194	0.167
20		20	81	0.420	0.494	0.493	0.986	0.388	0.105
21		17	63	0.381	0.365	0.296	0.661	0.259	0.037
22		15	59	0.305	0.390	0.347	0.737	0.265	0.082
23		26	88	0.273	0.398	0.320	0.718	0.293	0.027
<i>totals</i>		<i>GP</i>	<i>PA</i>	<i>RPA</i>	<i>OBP</i>	<i>SLG</i>	<i>OPS</i>	<i>AVG</i>	<i>ISO</i>
<i>N = 23</i>	<i>All Pre-Post</i>	20	72	0.321	0.394	0.359	0.753	0.273	0.086
<i>N = 22</i>	<i>PD</i>	19	69	0.308	0.375	0.341	0.717	0.260	0.081
<b><i>N = 8</i></b>	<b><i>PD+S&amp;C</i></b>	<b>21</b>	<b>85</b>	<b>0.365</b>	<b>0.444</b>	<b>0.422</b>	<b>0.866</b>	<b>0.309</b>	<b>0.113</b>
<i>N = 14</i>	<i>PD-S&amp;C</i>	18	65	0.298	0.363	0.320	0.683	0.250	0.069
<i>N = 15</i>	<i>Non S&amp;C</i>	<i>no data</i>							

<b>Table 3</b>					
<b>Significant Correlations</b>					
		<i>Observation 2</i>		<i>Observation 1 &amp; 2</i>	
		<i>BATS Post-Testing</i>		<i>Gain Scores</i>	
	<b>RPA</b>	GS	BBV	GS	BBV
N = 23	All Pre-Post	0.4221	0.3337	-0.0306	0.1864
	<b>OPS</b>				
N = 23	All Pre-Post	0.3353	0.6665	-0.0277	0.2519
	<b>SLG</b>				
N = 23	All Pre-Post	0.3522	0.06839	-0.0484	0.2321
	<b>ISO</b>				
N = 23	All Pre-Post	0.3792	0.5822	0.0792	-0.1223

## PROCESS: HANDGRIP STRENGTH

Muscles in the forearms and wrists are the origin of GS and together provide complex, tri-planar mobility and stability out the kinetic chain from the elbows to the wrists and fisted hands in the baseball swing. Muscles involved in GS are grouped into extrinsic and intrinsic abductors, adductors, flexors, extensors, supinators, and pronators (4). The forearms facilitate muscular and gravitational forces, via concentric and eccentric muscular contractions respectively, during the baseball swing. These forces are produced via a dynamic lateral drive to generate impulse-momentum up and out the kinetic chain from feet-to-fingertips. Matt Nokes, a 1987 American League Silver Slugger, identifies the actions in this process as “leaning to the speed” with the “head in the fire” in a “ride-and-stride” action linking a “power core turn” into a “cross-body, cross-the-face, sideways,” striking motion (5,6,7). The resultant forces of this motion extend out of the hands and through the long lever that is the baseball bat, thus producing BBV as a product of the violent bat-ball collision.

GS functionality transitions from bat acceleration (in the approximate 0.14s or 140ms of movement/swing time to contact with a fast swing in response to a 90mph pitch) into bat deceleration (in the approximate 0.04s or 40ms of follow-through) after bat-ball contact (8). Hitting a baseball is a process of this complex sequence of events that, when performed in sync, could be considered as a dance between hitter and pitcher requiring rhythm and tempo to put the

bat on the baseball in the right place, at the right time, within the right space (5,6,7). GS is an important element of this dance and contributes primarily to the batter's ability to hold onto the bat speed produced by the feet-to-fingertip batting motion. In his seminal work, *The Science of Hitting*, Hall of Famer Ted Williams wrote:

From the stance to the completion of the swing, hands and forearms supply direction. The grip is firm, with the bottom hand holding the bat like a hammer and the index finger slightly open... The wrists do not roll. Action at point of impact is comparable to that of the hard, unbroken swing of an ax (9).

This palm-up-palm-down grip and production of a slight upswing to level-swing could not be completed without ample grip strength and grip endurance (5,6,7,9). In fact, Williams further stated:

the impact of bat on ball is reached *not* with the wrists rolling, or a 'wrist' swing, but with the wrists square and *unbroken*, as they would be at impact when an ax is swung on a tree. The power is always applied before the wrists roll. Even when you are pulling? Yes, because the hips bring the bat around, not the wrists (9).

Recent studies on GS within the current body of literature have identified an array of general findings. Grip strength has proven to be a good indicator of physical readiness and fatigue in firefighters (10). Hand circumference is a better indicator and/or predictor of GS than BMI and forearm circumference (11). The 10% Rule indicates a 10% difference between dominant and non-dominant grip strength in right-handed individuals, but little to no difference between dominant and non-dominant grip strength in left-handed individuals (12). This study identifies the following process findings as related to baseball hitting:

- Gain Scores from BATS pre-test to post-test GS for the participant population N=23 were +6.7kg and the following is a break down according to sub-populations (Table 1):
  - N=8 PD+S&C +7.8kg (Table 1)
  - N=14 PD-S&C +6.0kg (Table 1)
- A 0.3522 correlation between BATS post-test GS scores and SLG which reaches a 0.05 Pearson's r level of significance for one-tailed test (Table 3).

- A 0.3792 correlation between BATS post-test GS scores and ISO which reaches a 0.05 Pearson's  $r$  level of significance for one-tailed test (Table 3).

## OUTCOME: BATTED BALL VELOCITY

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BBV is an important outcome generated from this process that, when significant enough and at the right trajectory, is the precursor to power hitting performance in baseball. Robert K. Adair, Ph.D., Sterling Professor Emeritus of Physics at Yale University and author of *The Physics of Baseball* wrote:

Very large forces are required to change the motion of the 5 1/8-ounce ball from a speed of 90 mph toward the plate to a speed of 110 mph toward the center-field bleachers in the 1/1000 of a second of bat-ball contact. Hence, for a long home run, the force on the ball reaches a value near 9000 pounds, with an equal reactive force on the bat. Such forces distort bat and ball: The ball is compressed to about half of its original diameter, the bat is compressed about 1/25 as much (13).

Adair goes on to state:

For the sake of definitiveness, in the following discussion I consider a bat 34 inches long and weighing 32 ounces striking a waist-high pitch such that the plane of the swing lies at 10 degrees from the horizontal (i.e., the bat is swung slightly upward) to drive a ball at an angle of 35 degrees... a ball crossing the plate at a velocity of 85 mph will travel when hit solidly with a full swing as a function of bat speed. I assume further that the ball is hit near the point of maximum hitting efficiency (the sweet spot...), and the quoted velocity is the velocity of that spot – the end of the bat will be traveling about 15 or 20 percent faster. Moreover, I assume that the ball is hit toward center field. Thus, a bat speed of about 70 mph is required to hit a ball 400 feet (13).

Additionally, Adair notes, “For a given bat speed, a solidly hit fastball goes further than a well-hit slow curve... The swing that hits a fungo (but with the bat described above, not a fungo bat) 340 feet will drive the 90-mph fastball 410 feet!” (13)

This study identifies the following outcome findings as related to baseball hitting:

- Gain Scores from BATS pre-test to post-test BBV for the participant population N=23 were +2.0mph and the following is a break down according to sub-populations (Table 1):
  - N=8 PD+S&C +2.6mph (Table 1)
  - N=14 PD-S&C +1.6mph (Table 1)
- A 0.6839 correlation between BATS post-test BBV scores and SLG which reaches a 0.005 Pearson’s r level of significance for one-tailed test (Table 3).
- A 0.5822 correlation between BATS post-test BBV scores and ISO which reaches a 0.005 Pearson’s r level of significance for one-tailed test (Table 3).

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## PERFORMANCE: SLUGGING PERCENTAGE, AND ISOLATED POWER

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Although brought to the masses in Michael Lewis’ book *Moneyball*, Bill James is really the father of modern-day baseball analytics (14). Joe Vasile, *Mets 360* Author, wrote, “sabermetrics has revolutionized baseball analysis and changed ways of thinking about the game” (15). Vasile goes on to state, “Even among casual fans, batting average is replaced with weighted On Base Average (wOBA)... Runs Batted In are eschewed in favor of Slugging Percentage (SLG) and Isolated Power (ISO)” (15). Major League Baseball Franchises that embrace both traditional scouting and progressive player analytics are those who are most likely to sustain success over a longer period of time than those who do not maintain some balance between these two baseball operations components.

Taking this a step further, it would be an ideal practice to take a more holistic approach to player development and player analysis. Giving analysts, scouts, player development personnel, sports medicine staff, and strength and conditioning coaches a seat at the table to

provide input on draft selection, trade considerations, and player development decisions would be a wise choice. This study attempts to break down the walls that exist between these different roles by identifying commonalities between process, performance, and outcome.

The prior two sections of this article identify GS as an important process measure and BBV as an important outcome measure of hitting a baseball for power. SLG and ISO are recognized as performance measures in this study and are identified in the formulas below for any and all references and calculations (16,17):

$$SLG = \frac{TB}{AB} \text{ or } SLG = \frac{(1b)(2x2b)(3x3b)(4x4b)}{AB}$$
$$ISO = \frac{SLG}{AVG} \text{ or } ISO = \frac{((2b)(2x3b)(3x4b))}{AB} \text{ or } SLG \frac{Extra-Bases}{At-Bats}$$

In addition to the statistically significant, positive correlations identified in the previous two sections of this article, this study identifies the following performance findings as related to baseball hitting for both the entire participant population and sub-populations:

- N=23 All Pre-Post SLG=0.359 ISO=0.086 (Table 2)
- N=8 PD+S&C SLG=0.422 ISO=0.113 (Table 2)
- N=14 PD-S&C SLG=0.320 ISO=0.069 (Table 2)

## CONCLUSION

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This article identifies a strong positive correlation between GS and SLG, a strong positive correlation between GS and ISO, a strong positive correlation between BBV and SLG, and a strong positive correlation between BBV and ISO. Altogether, these correlations link process in GS and outcome in BBV with performance in SLG and ISO in the skill of baseball hitting. Of special note, the highest average GS and BBV gains were made by athletes who participated in both PD and S&C activities in comparison to their peers. This validates the

concept of sweat equity with intent, which is the theory of working hard toward process, performance, and outcome goals within a mental preparation plan. This study justifies the need for an in-season GS training component, but grip endurance should be a significant consideration due to the nature of the daily grind that is a baseball schedule and overtraining grip strength should be avoided.

More extensive research on in-season and off-season GS training, balance and postural stability, lateral drive, rotational power, and weighted implements is needed to further understand power potential in baseball hitters. While this study merely scratches the surface of integrating process, performance, and outcome measures in an interrelated manner, future research on a holistic model for baseball player development via a true multi-disciplinary approach would be useful for movement practitioners. Finally, more data is required should the correlations documented in this study be truly intended for detailed predictive purposes.

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