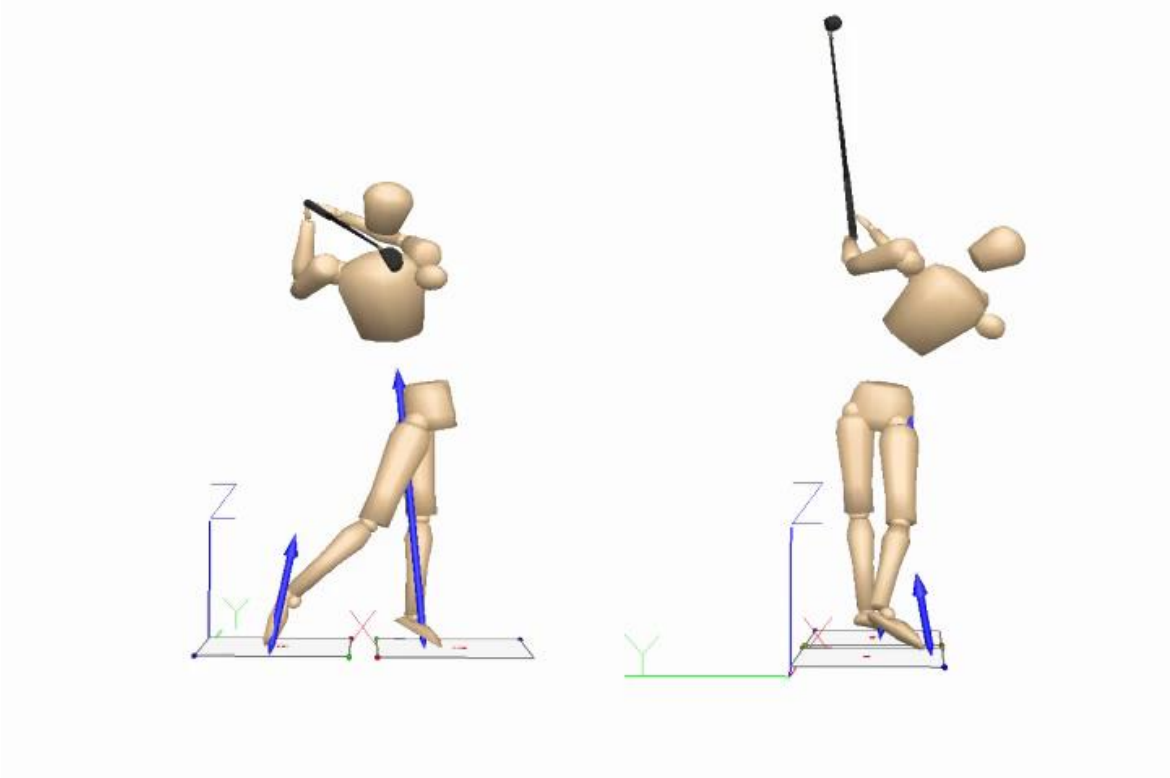
Understanding Leg Dominance in order to Optimize Ground Reaction Forces and Pressure Shifts in the Golf Swing

Dr. Scott Lynn



Variability in Golf Kinetics

- Great variability in golf kinetics.

- It can be hypothesized that these differences in swing styles can be determined by:
  - Anthropometric differences between golfers
  - Differences in fundamental movement patterns

Pressure Distribution Averages

		Drivers (n=86, 23 sub)	Mid irons (n=102, 24 sub)	Short irons (n=71, 17 sub)
Position	**Foot**	**Mean ± SD %**	**Mean ± SD %**	**Mean ± SD %**
Address	Back	**46.3** ± 8.3	**46.0** ± 7.6	**46.8** ± 7.4
	Front	**53.7** ± 8.3	**54.0** ± 7.6	**53.2** ± 7.4
Top	Back	**78.3** ± 14.0	**75.3** ± 12.4	**71.7** ± 11.6
	Front	**21.7** ± 14.0	**24.7** ± 12.4	**28.3** ± 11.6
Impact	Back	**24.1** ± 17.7	**18.2** ± 10.5	**15.8** ± 8.8
	Front	**75.9** ± 17.7	**81.8** ± 10.5	**84.2** ± 8.8
Clubhead speed (mph)		**109.6** ± 3.6	**93.5** ± 4.1	**86.1** ± 3.0

Total n=259 (25 golfers)

Variability

- Standard Deviations
  - A measure used to quantify the amount of variability or dispersion in the data.
  - Example:
    - Pressure on lead foot at impact, Group A (5 golfers)
      - 80%, 80%, 80%, 80%, 80%
      - Avg = 80%, SD Dev = 0%
    - Pressure on the lead foot at impact, Group B (5 golfers)
      - 90%, 70%, 75%, 85%, 80%
      - Avg = 80% , SD Dev = 8.0%

Averages and Ranges

Variable	Mean ± SD	Range
Pressure R imp (%)	24.1 ± 17.7	**0 - 96.4**
Pressure L imp (%)	75.9 ± 17.7	**3.6 - 100**

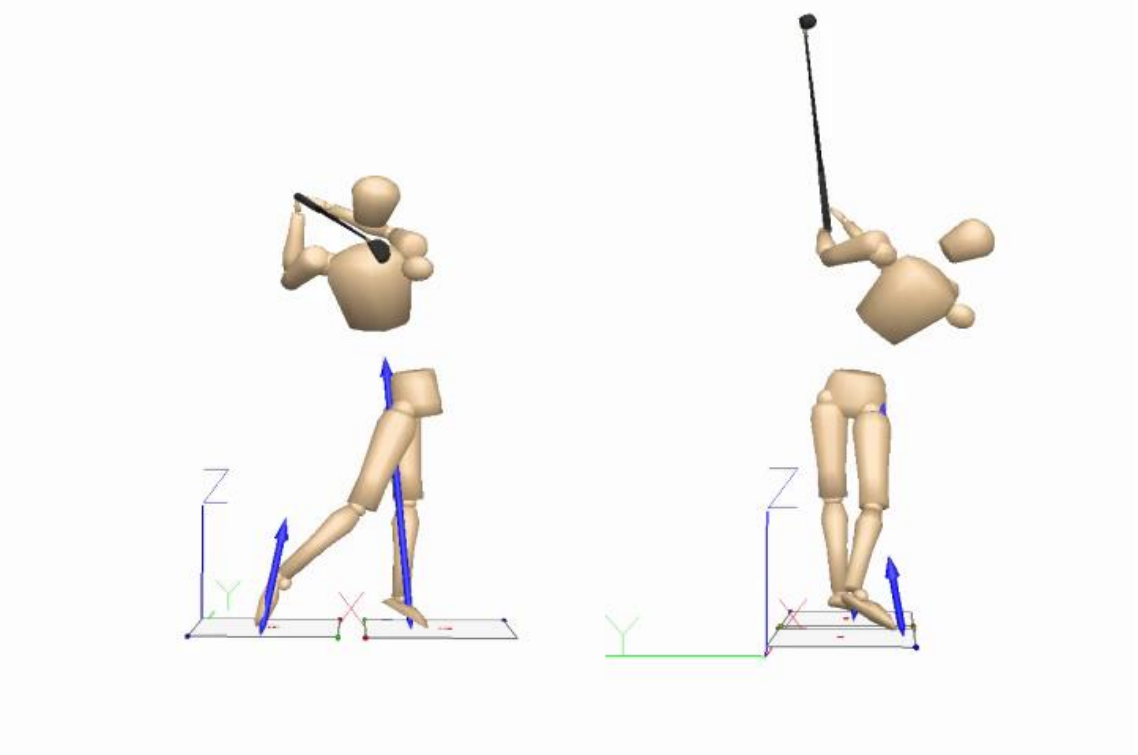
DRIVER (23 golfers, n=86)

McGhie (Unpublished Data)


Capture Off
Manual Trigger
Capture Options
View Modes
Screen Layout
Progress
Record Lesson
Record
swingcatalyst
Pressure and Stance
41%
23 in
59%
Empty

Newton's 3rd Law
Ground Reaction Forces (GRFs)

- For every action, there is an equal and opposite reaction.
- Ground Reaction Forces (GRF) are the only external force available to us in golf.
- Golf swings would be impossible without them.

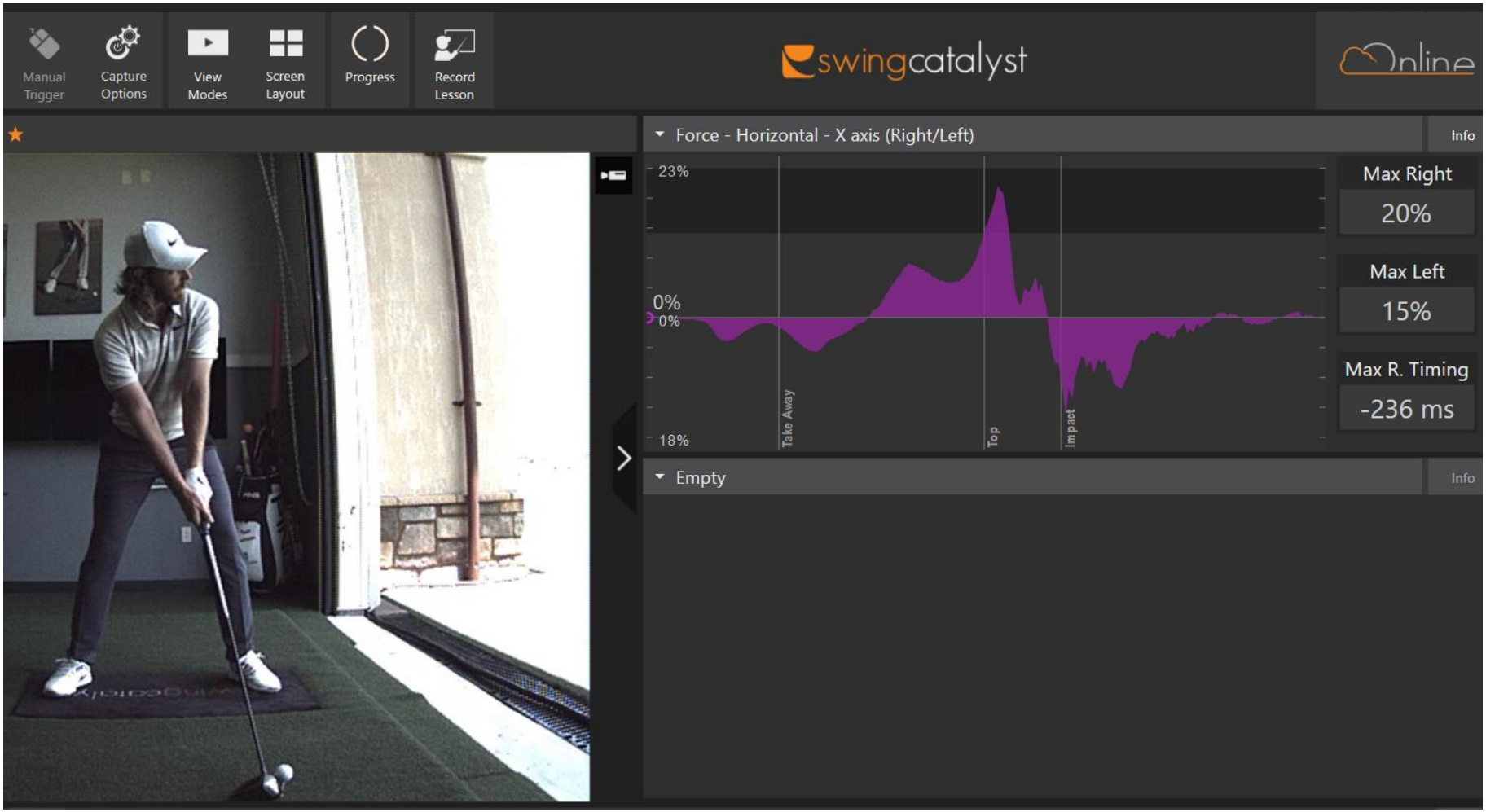


Possible GRF Power Sources

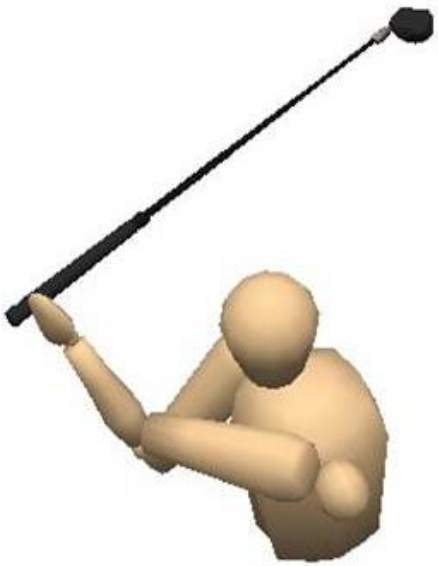
- HORIZONTAL/LINEAR/FRONTAL PLANE FORCE
- TORQUE/ROTATIONAL/TRANSVERSE PLANE FORCE
- VERTICAL/SAGITTAL PLANE FORCE

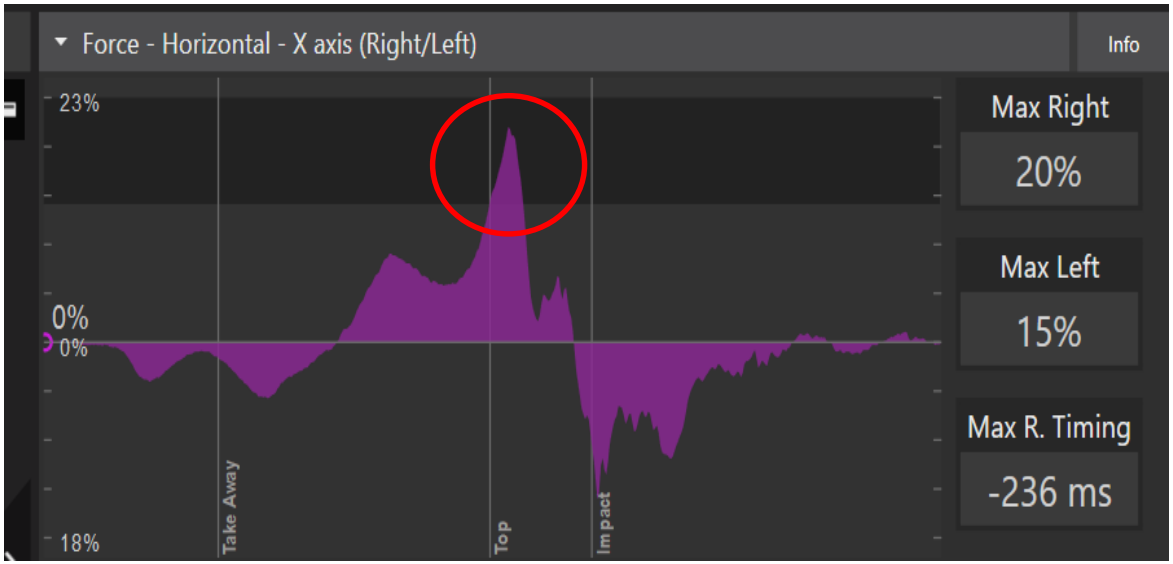
- All players use all three power sources but to different magnitudes.

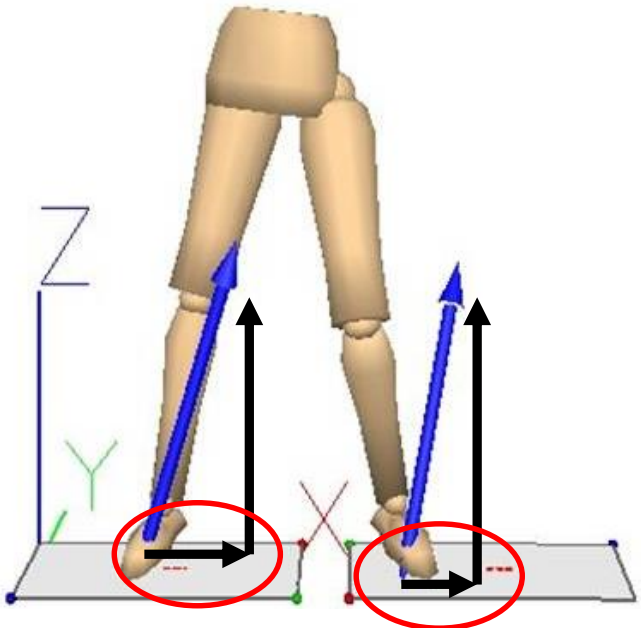
Horizontal Force(Right/Left)



Horizontal Force(Right/Left)

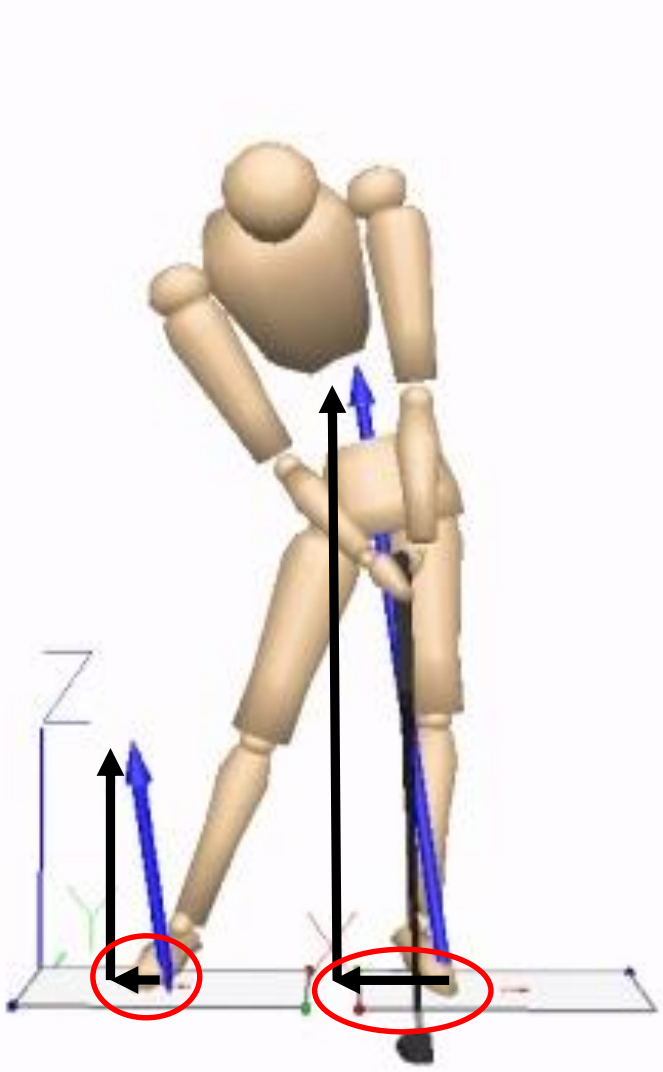


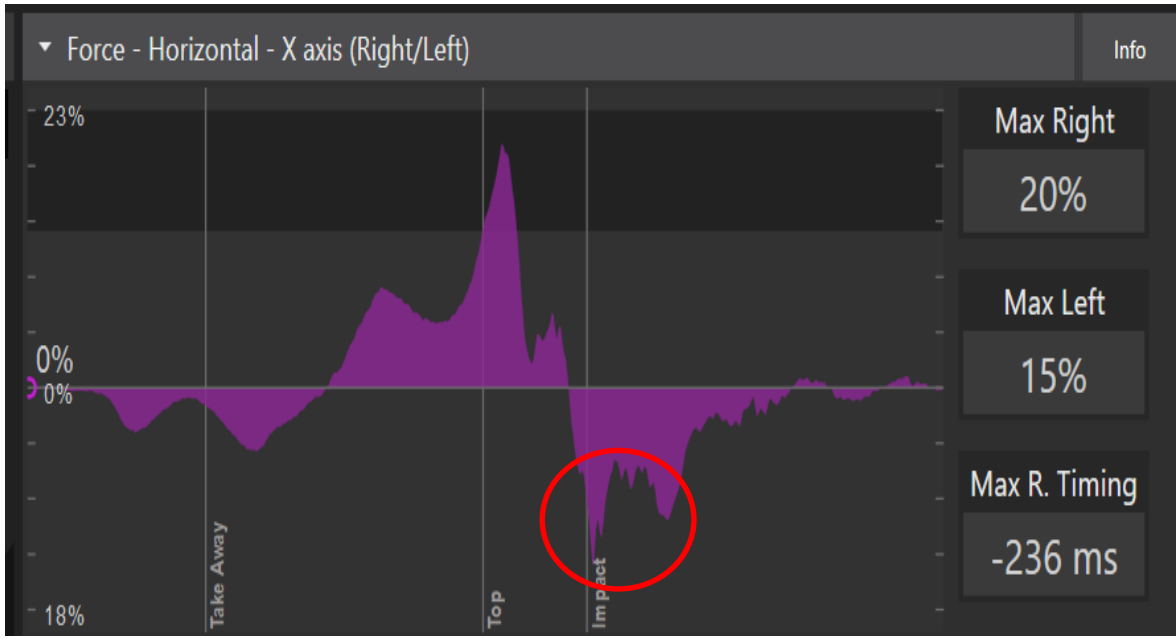




- Positive = towards the target reaction force
- Negative = away from the target reaction force.

Horizontal Force(Right/Left)

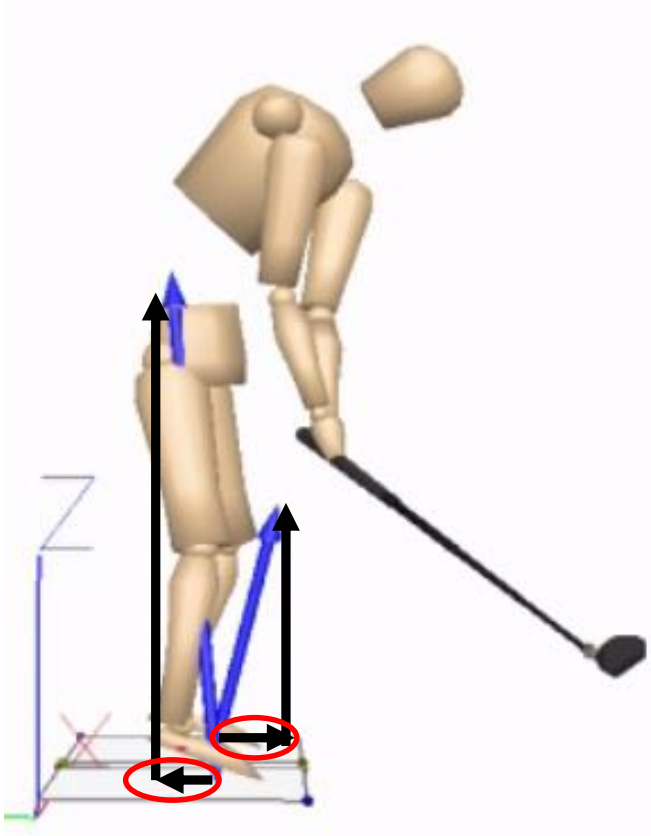




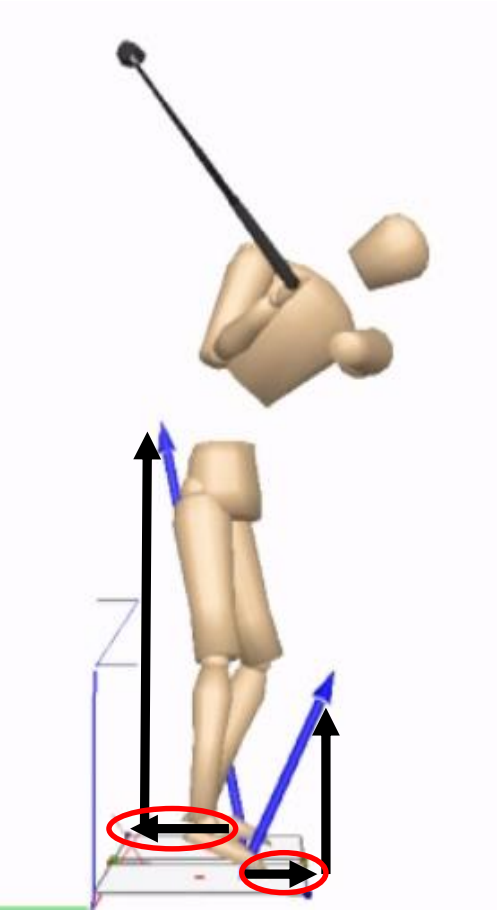
- Positive = towards the target reaction force
- Negative = away from the target reaction force.

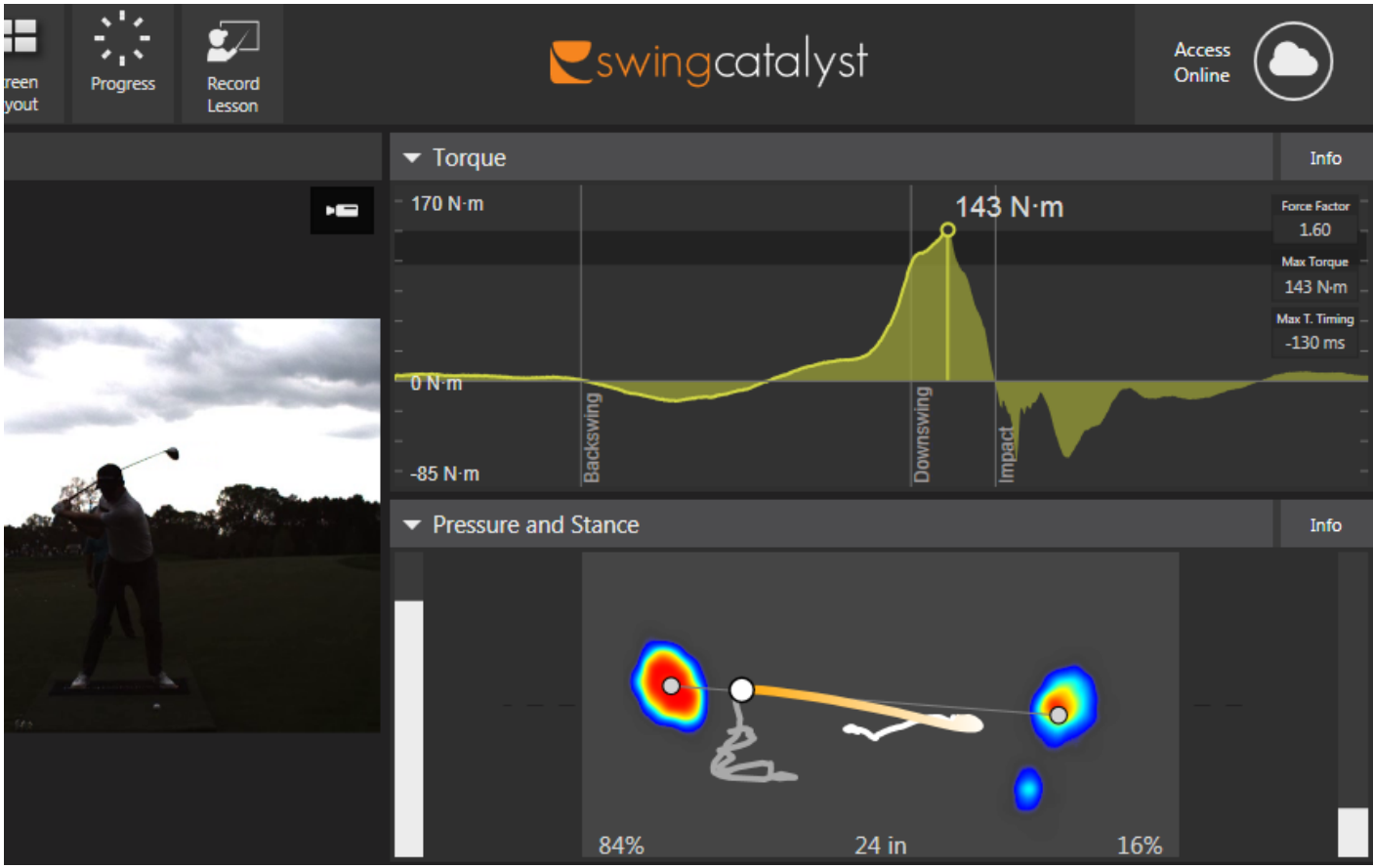
Charles Howell III – Frontal Plane

Torque - Spinner

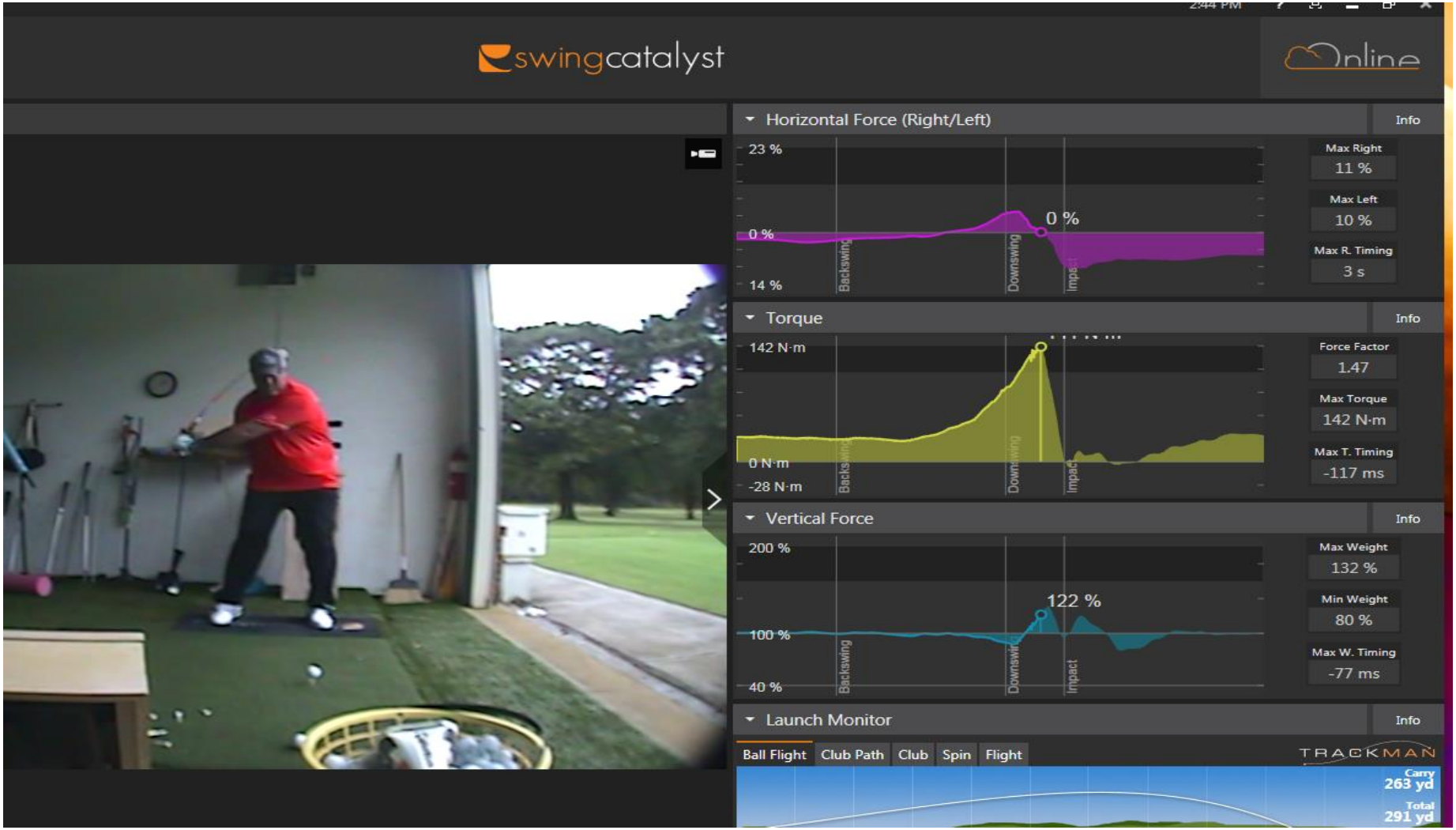


Torque - Spinner





Boo Weekley – Transverse Plane



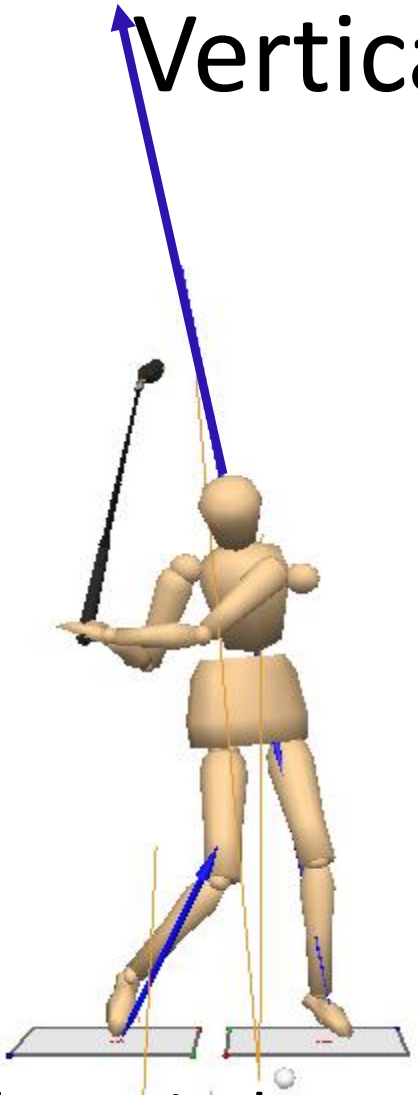
Horizontal vs. Torque

Coaching Torque

Matt Wolff


Manual Trigger
Capture Options
View Modes
Screen Layout
Progress
Record Lesson
swingcatalyst
Online
Pressure and Stance
Info
39%
24.4 in
61%
Torque
Info
142 N·m
0 N·m
-57 N·m
-10 N·m
Take Away
Top
Impact
Force Factor
1.43
Max Torque
120 N·m
Max T. Timing
-108 ms

Vertical Force – Sagittal Plane



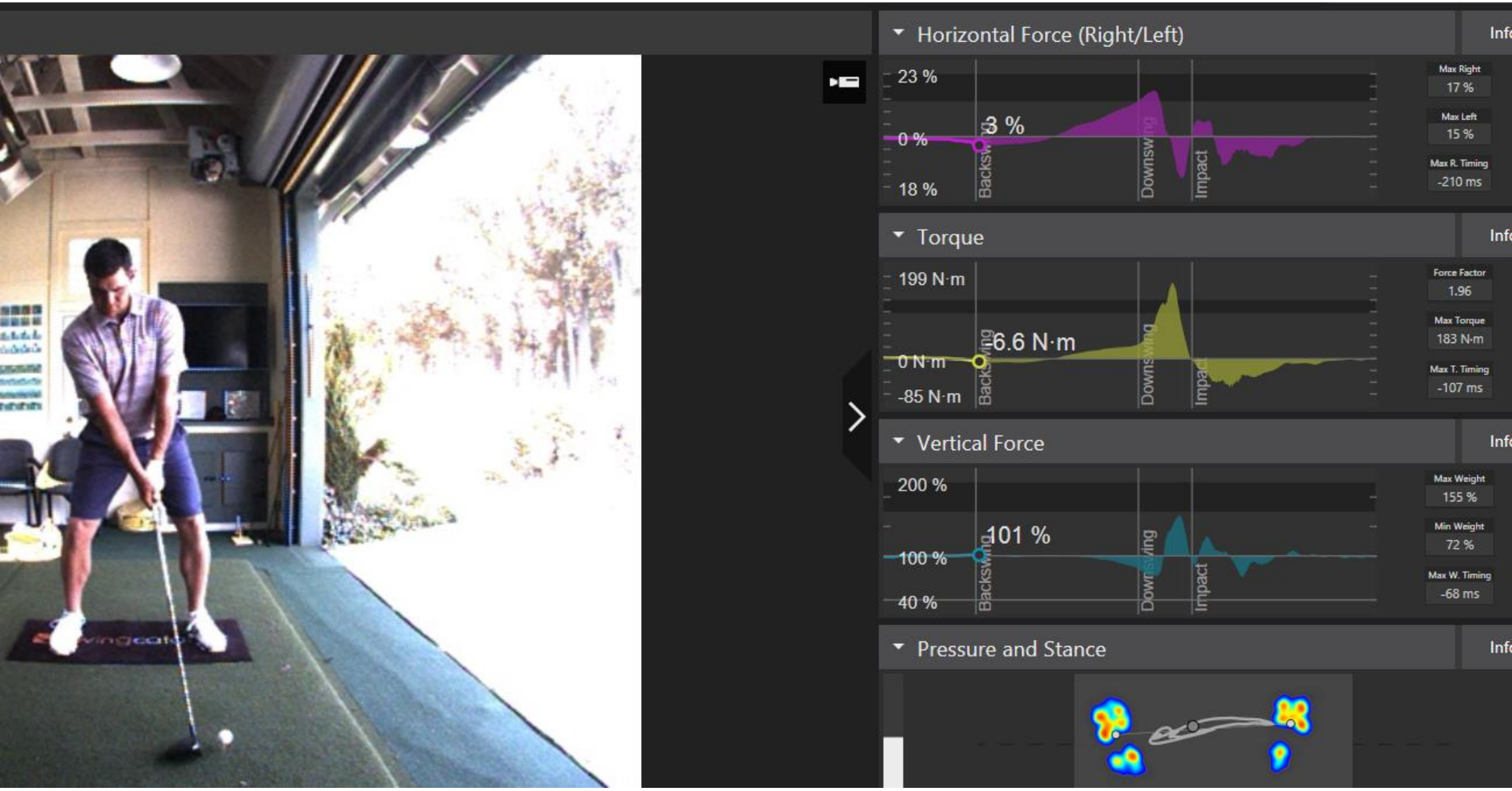
Peak Vertical Force on left leg = 1788 Newtons

Force of Gravity

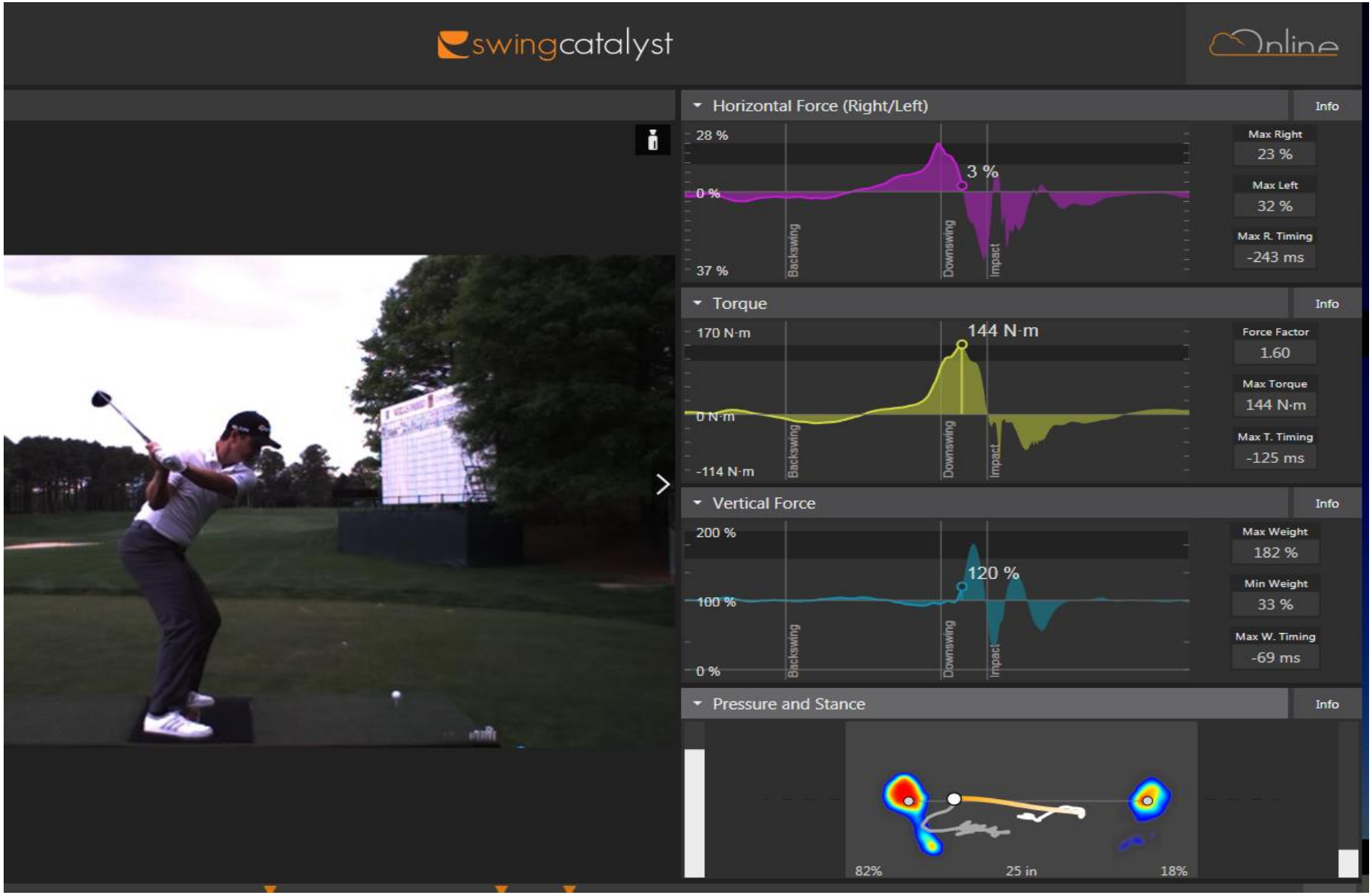
- Always acts down in the vertical direction.
- $F_{Gravity} = mg$
- g = acceleration due to gravity (9.81 m/s^2)
- 1788 N/9.81 m/s^2 = 182 kg (approx. 400 lbs)

Justin James

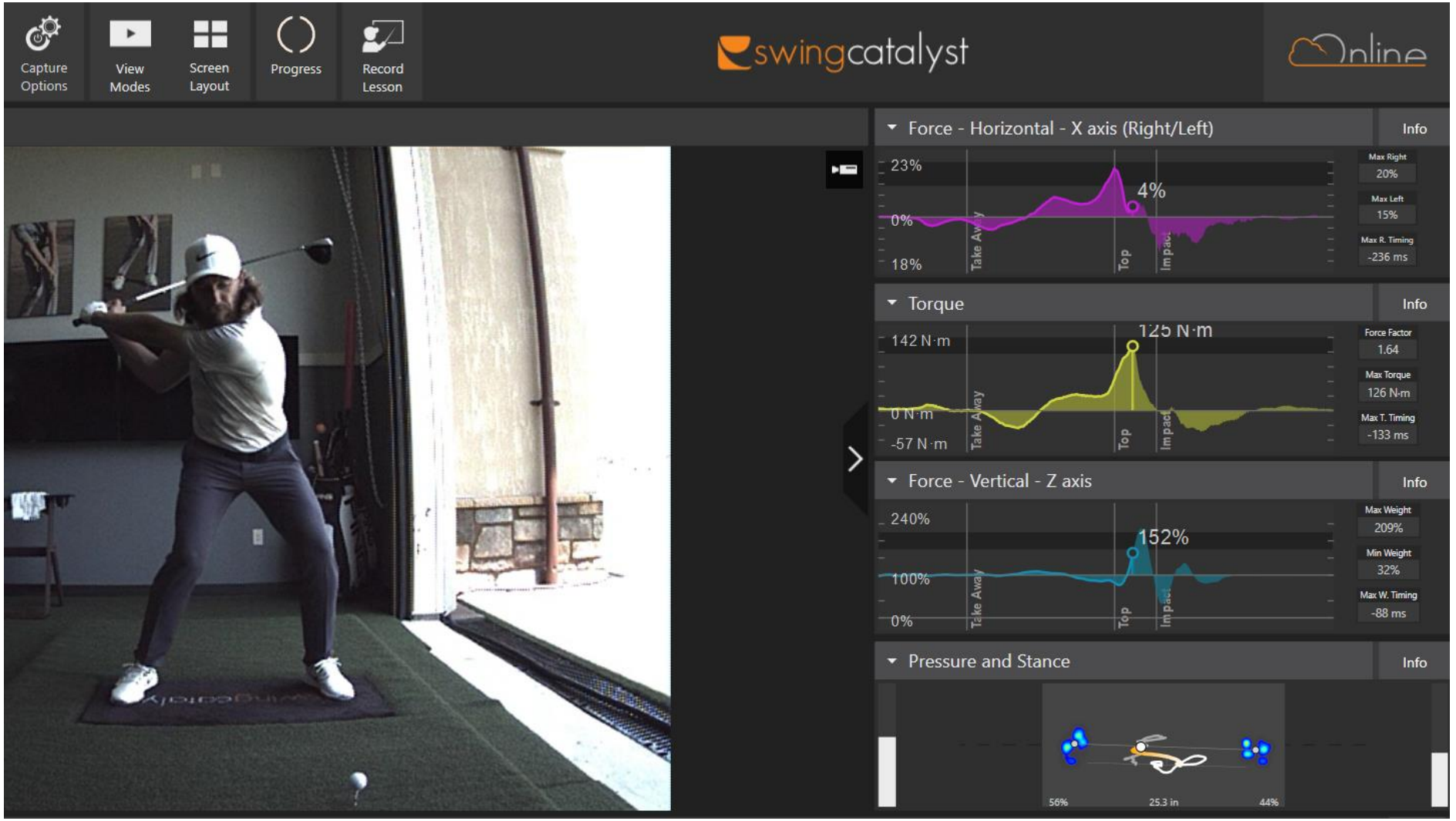
Gary Woodland – Low Vertical



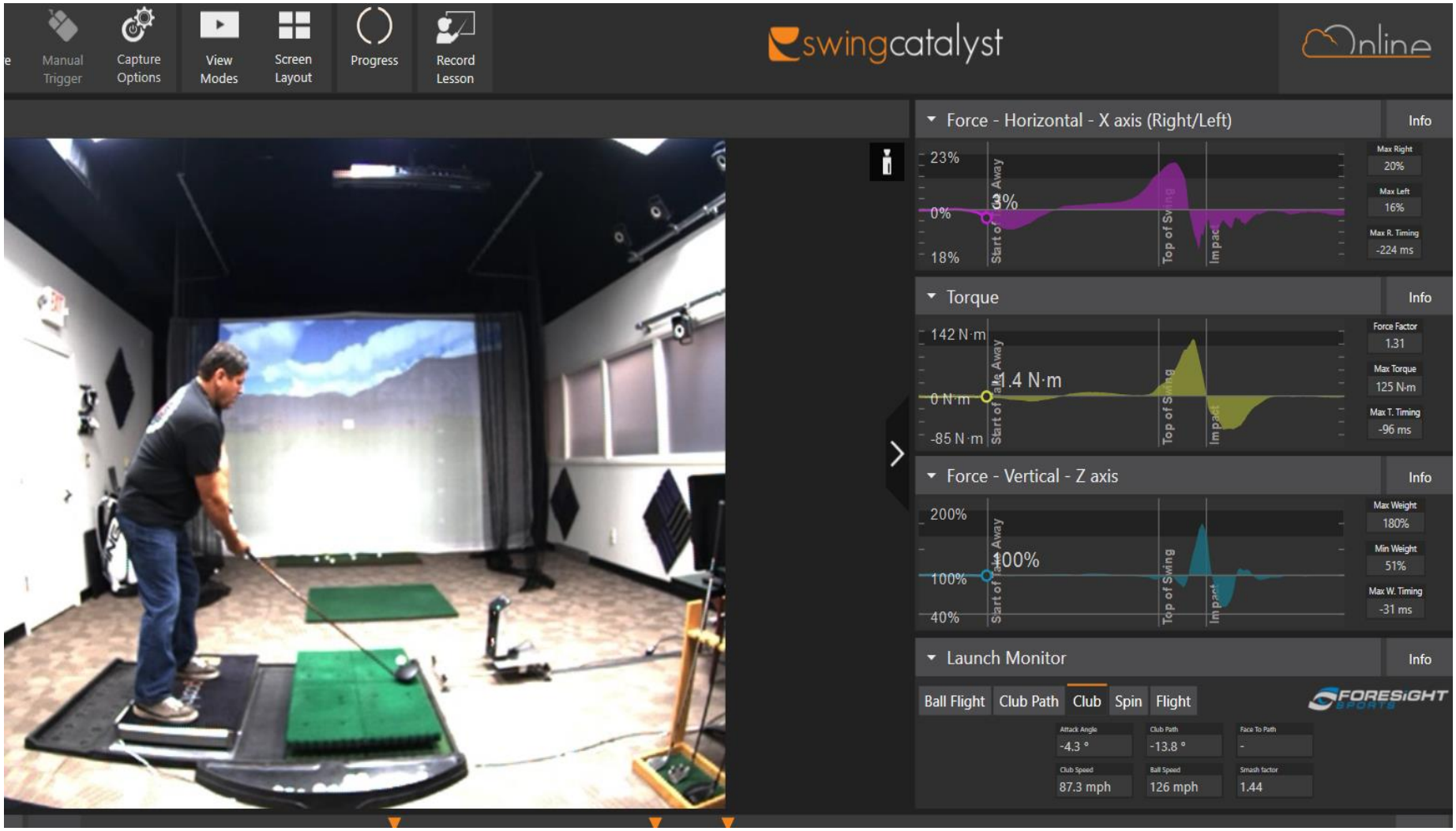
Justin Rose – Rare “Trifecta”



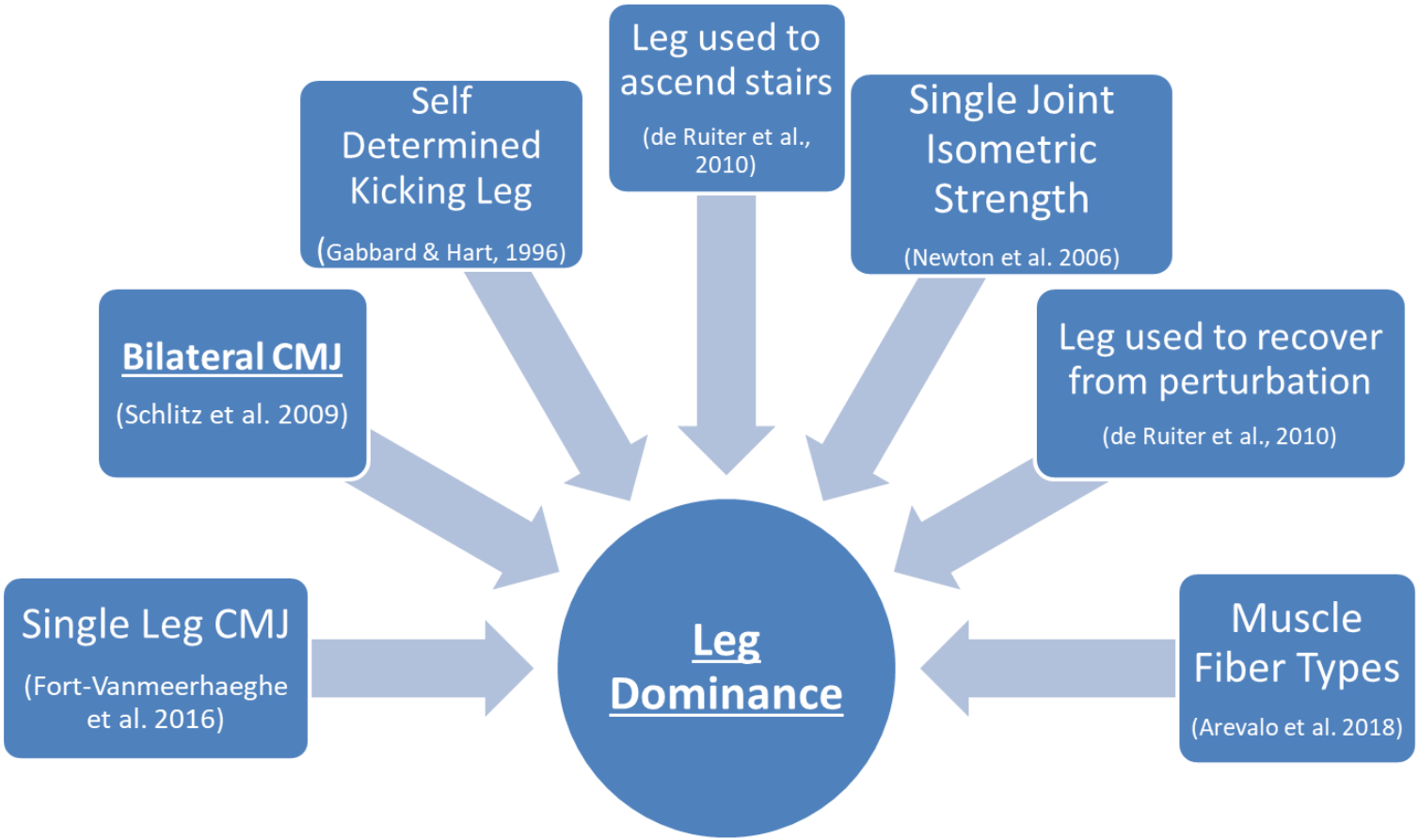
Tommy Fleetwood – Rare “Trifecta”



Trifecta?


Manual Trigger
Capture Options
View Modes
Screen Layout
Progress
Record Lesson
swingcatalyst
Online
Force - Horizontal - X axis (Right/Left)
Info
23%
0%
18%
Max Right
20%
Max Left
16%
Max R. Timing
-224 ms
Torque
142 N·m
0 N·m
-85 N·m
1.4 N·m
Force Factor
1.31
Max Torque
125 N·m
Max T. Timing
-96 ms
Force - Vertical - Z axis
200%
100%
40%
Max Weight
180%
Min Weight
51%
Max W. Timing
-31 ms
Launch Monitor
Ball Flight
Club Path
Club
Spin
Flight
FORESIGHT SPORTS
Attack Angle
-4.3 °
Club Path
-13.8 °
Face To Path
Club Speed
87.3 mph
Ball Speed
126 mph
Smash factor
1.44

Leg Dominance



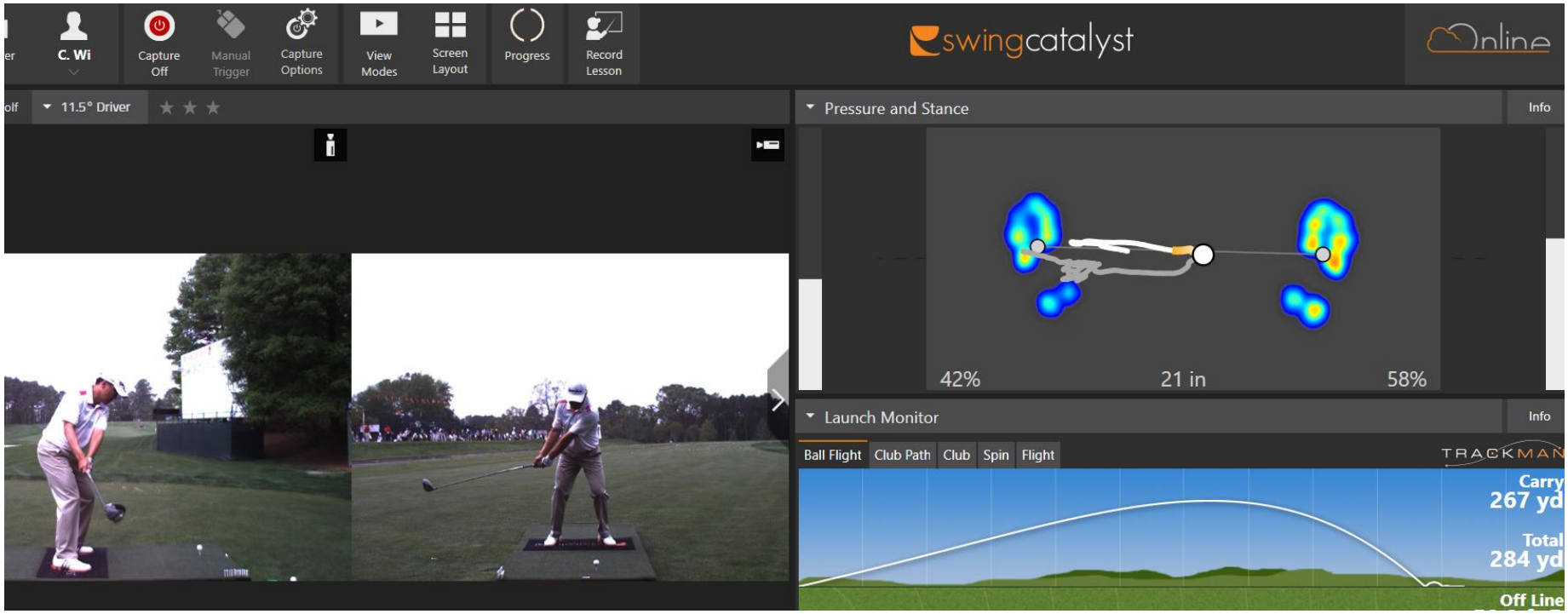
Garcia & Lynn (2018)

Left Leg Dominant

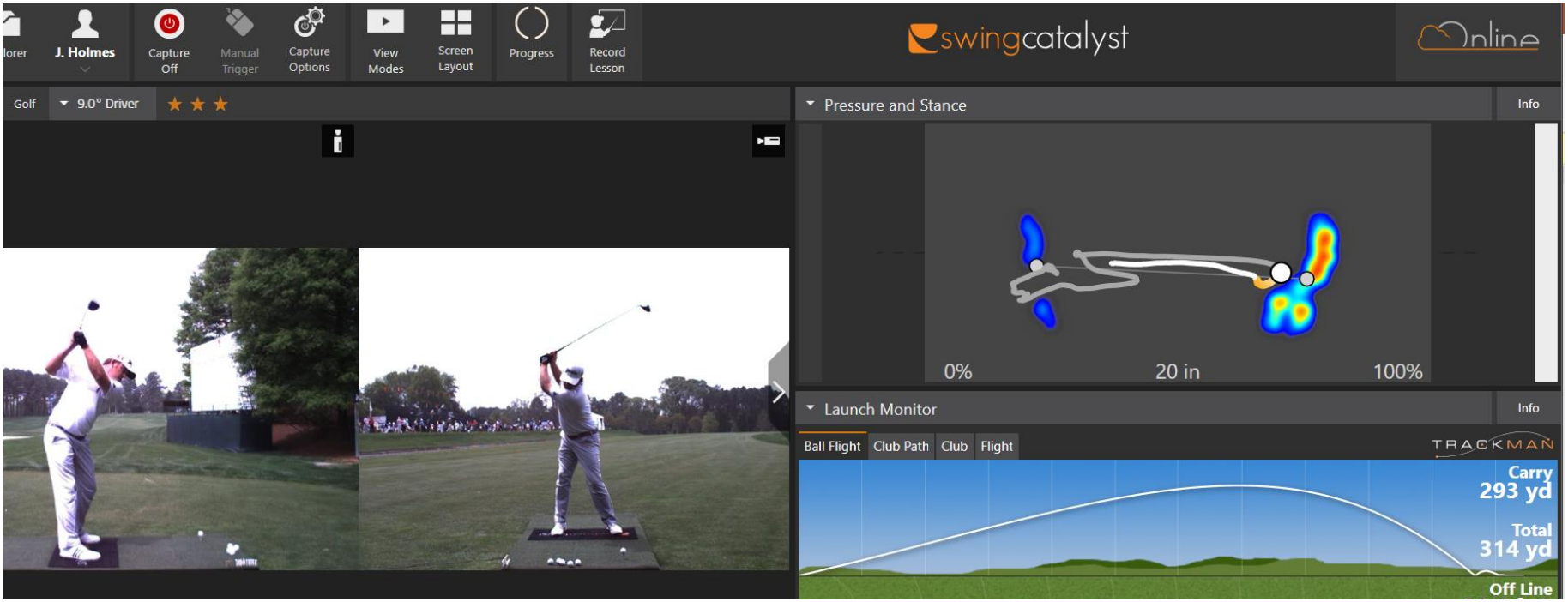
Right Leg Dominant

No Leg Dominance

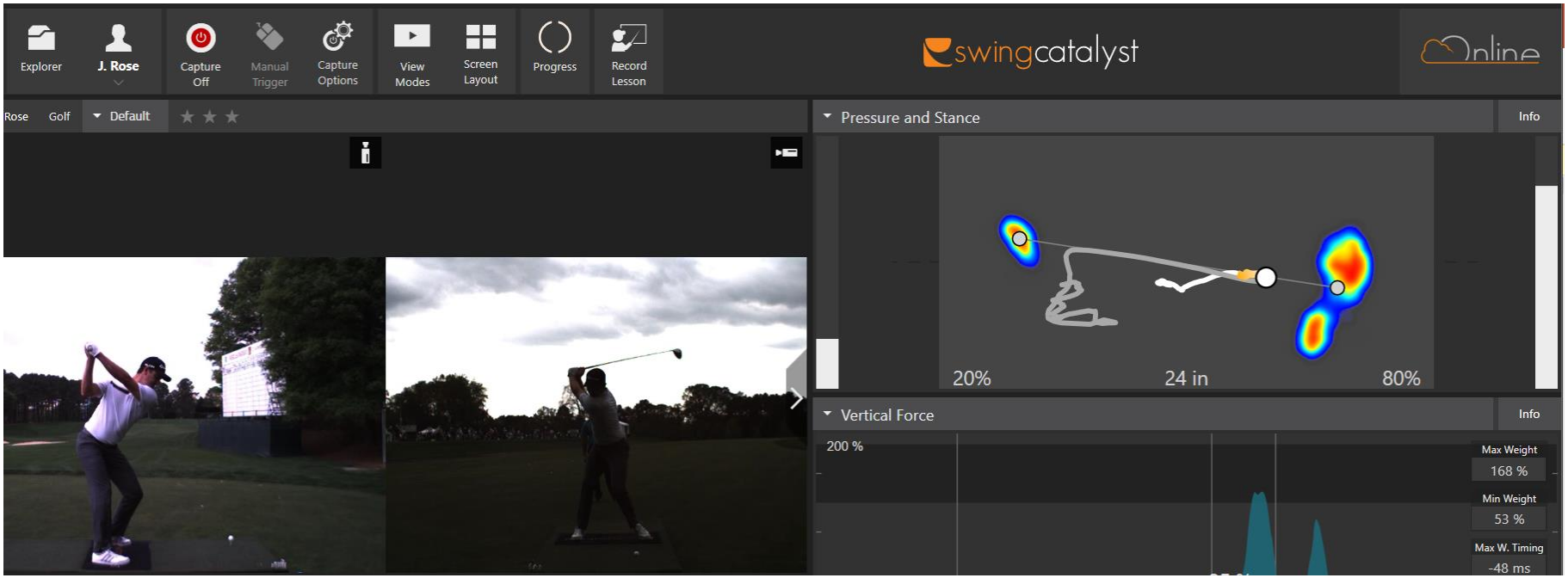
Left Leg Dominant - Vertical



Right Leg Dominant- Linear



No Leg Dominance - Torque



PING Study

	Slow	Medium	Fast
Speed	< 95mph	95mph – 105mph	>105mph
Driver Specifications	10.5° G400 Alta 55 R	10.5° G400 Alta CB 55 S	8.98° G400 LST Tour 65 X
Iron Specifications	30.04° G400 AWT 2.0 R	30.05° G400 AWT 2.0 S	33.00° I210 Dynamic gold x100
Number of participants	31	33	41
Handicap	11.25±10.91	9.81±7.34	5.27±5.49

- Jonathan Shephard & Erik Henrikson
- 5 swings with a 7 iron/5 swings with a driver

PING Study

Type	Vertical	Torque	Horizontal
Tour Averages	179 +/- 20.0 BW	127.7 +/- 16.0 Nm	19.0 +/- 4.1 BW
Instances (# swings)	351 (36%)	105 (11%)	513 (53%)

- Calculated Z-scores based on tour average data (z = (score – tour average)/SD)
- For each swing, determined what the dominant power source was (highest Z-score)

PING Study

Group	Horizontal		Torque		Vertical	
	Driver	7-iron	Driver	7-iron	Driver	7-iron
“R” Flex	65	85	23	8	52	46
“S” Flex	93	94	18	3	44	58
“X” Flex	85	91	38	15	67	84

- Using Z-scores determined what the dominant power source was for each swing across each group with each club.
- On average, are amateur golfers not good at producing torque?

Ping Study

Performance Variable/Launch Monitor Tendencies

	Horizontal	Torque	Vertical
Face Angle (deg)	0.53±5.39	-1.44±6.38	0.96±6.58
Angle of Attack (deg)	0.94±4.05	-0.16±4.39	1.02±3.79
Club Path (deg)	1.17±4.66	-1.56±5.35	-0.65±4.16
Closure Rate (deg/s)	2561±986	2857±682	2729±1379
Offline Distance (Yards)	-2.61±22.99	-5.57±28.08	0.20±18.25

Thank You
Questions?