



Olympic Weightlifting: Quantifying the Dynamics of the Clean

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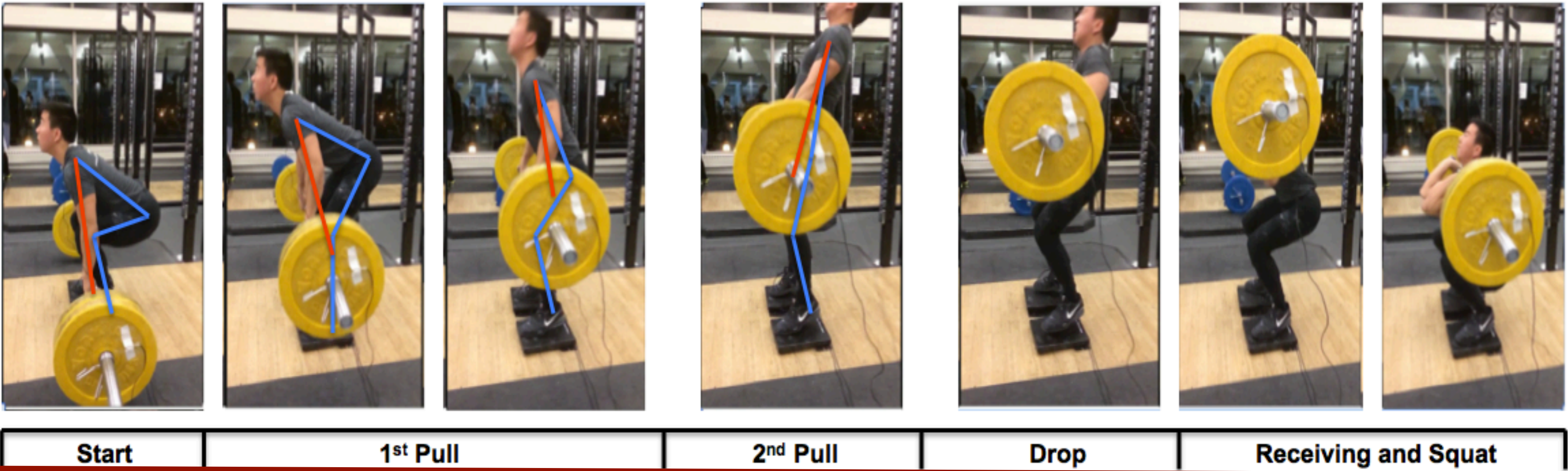
2.671 Measurement & Instrumentation

Abstract

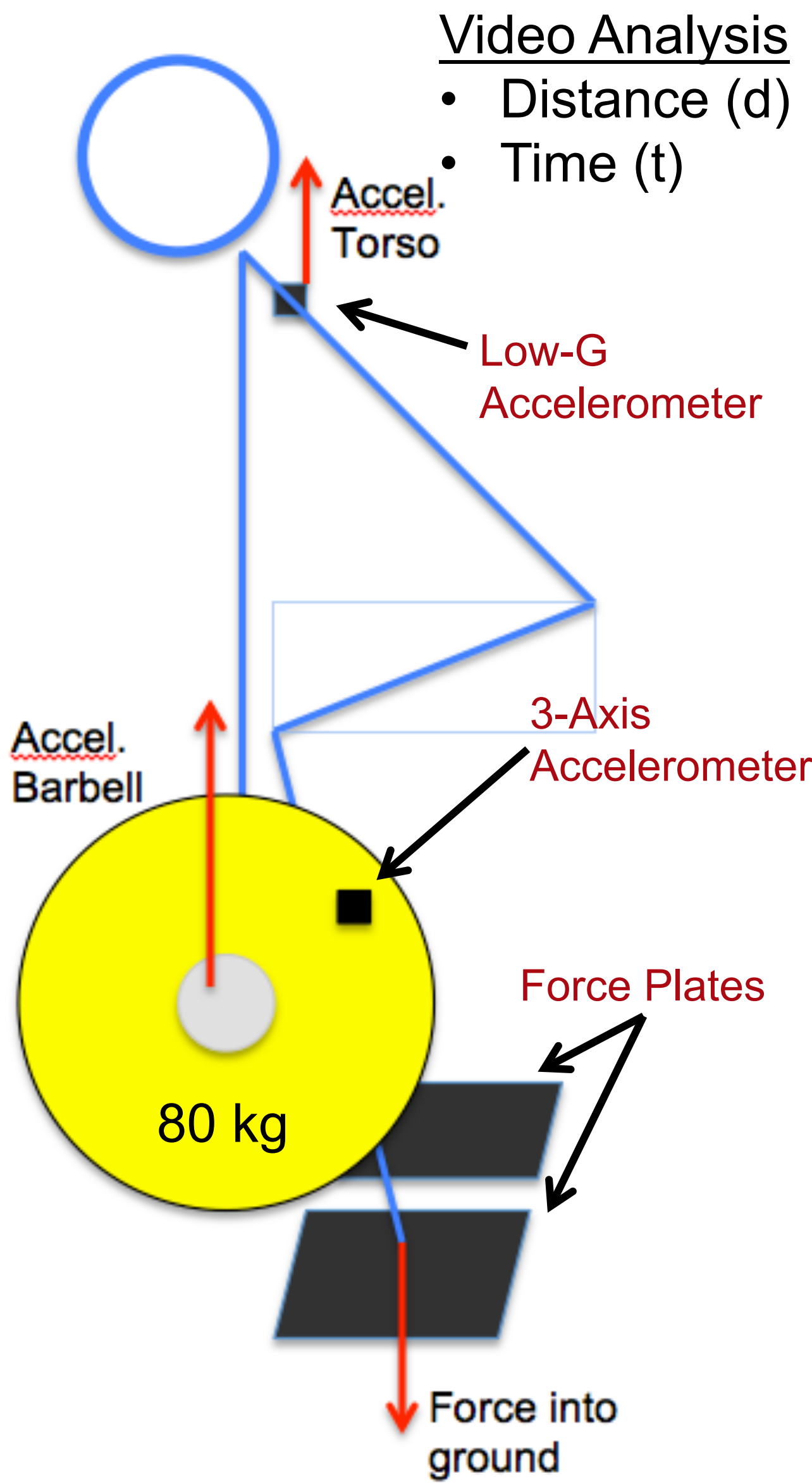
Olympic-style weightlifting is an extremely quick and explosive sport, with a high correlation between force exertion on the barbell and the acceleration of the barbell. Determinants of a successful lift are how high a weightlifter can propel the bar and also how fast a weightlifter is able to descend to receive the barbell at the full squat position. The position where the bar is propelled upwards with the greatest force occurs at the 2nd pull phase, when torque forces on the back are minimized. This study measured the peak force generated by a weightlifter during the clean movement, as well as the accelerations of the barbell and torso. With this data, the power generated during the clean was also determined. Overall, the measured peak force was $1940 \pm 220\text{N}$, the measured peak acceleration of the barbell was $21.8 \pm 3.7 \text{ m/s}^2$ and that of the torso was $40 \pm 19 \text{ m/s}^2$. The power generated by the 1st pull was $1170 \pm 430 \text{ W}$ while the power generated by the 2nd pull was $3100 \pm 350 \text{ W}$. The results demonstrate the explosive power generated by the power position during the clean, suggesting an effective way to train for ballistic strength.

Weightlifting Kinematics

Olympic Weightlifting involves the transfer of vertical force from the weightlifter to the barbell. The maximum force exertion occurs at the **2nd Pull** phase of the lift, when the hips, legs and torso extend in quick succession. At this point the torque forces on the back shift to compressive forces, allowing better leverage for muscle contraction.



Methods



Acknowledgements

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Conclusion

- The 2nd pull phase generates considerably more power and force than the 1st pull phase. The duration of the 2nd pull is also shorter.
- Force, acceleration and power can be quantified with barbell accelerometer measurements, but do not take into account additional force generated by the body to accelerate itself.
- The quantified acceleration and power data demonstrate good correlation with existing literature.

Further Studies

- Force exertion, acceleration and power at different 1 rep max percentages.
- Compare power and force generation from different starting positions (starting from ground versus directly at 2nd pull).

References

[1] Kimitake, Sato. "Barbell Acceleration Analysis on Various Intensities of Weightlifting", University of Northern Colorado, 2009.

Results

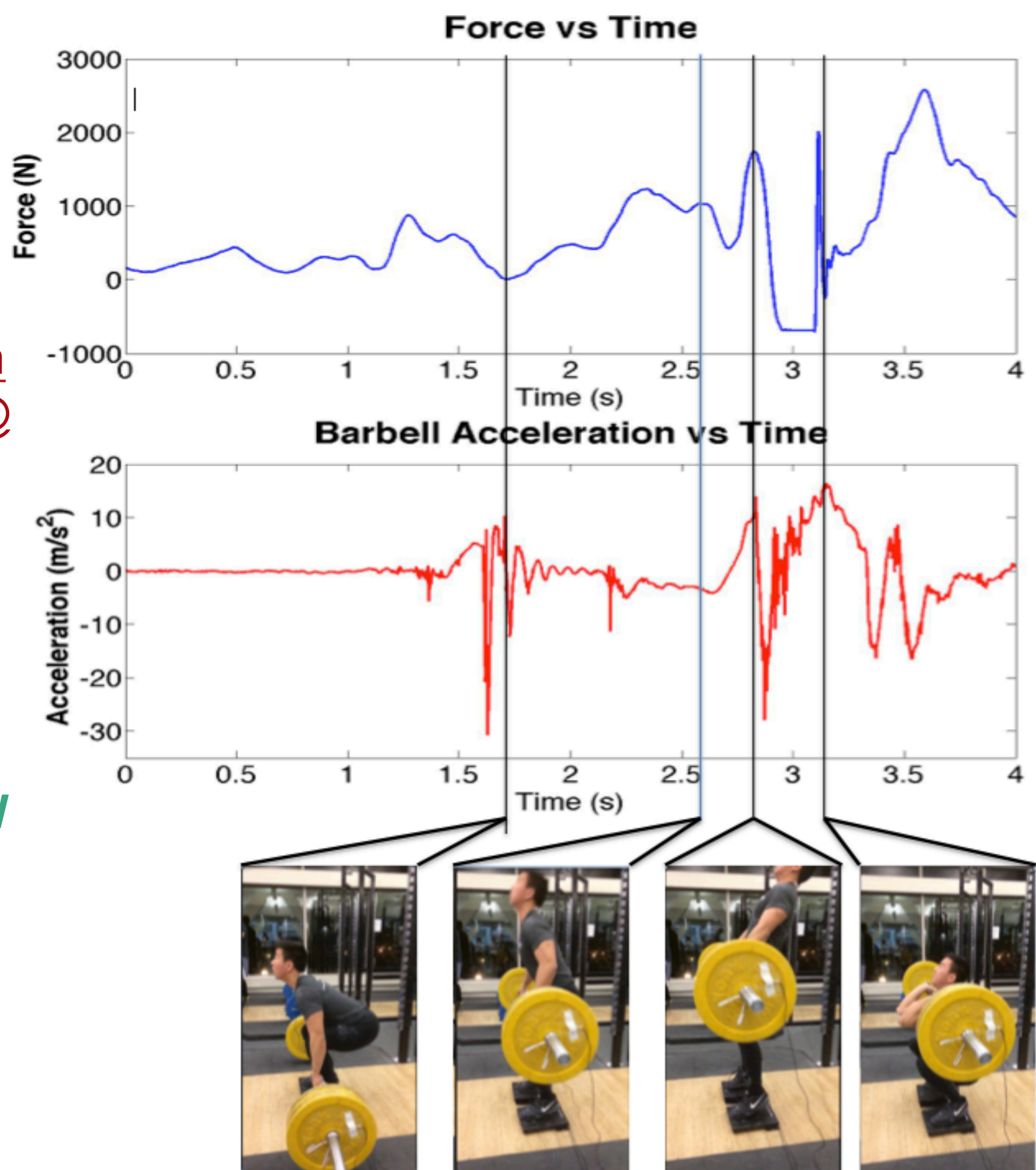
Peak force measured :
 $1940 \pm 220\text{N}$

Peak barbell acceleration:
 $21.8 \pm 3.7 \text{ m/s}^2$ @ 61% of 1 rep max for test subject.

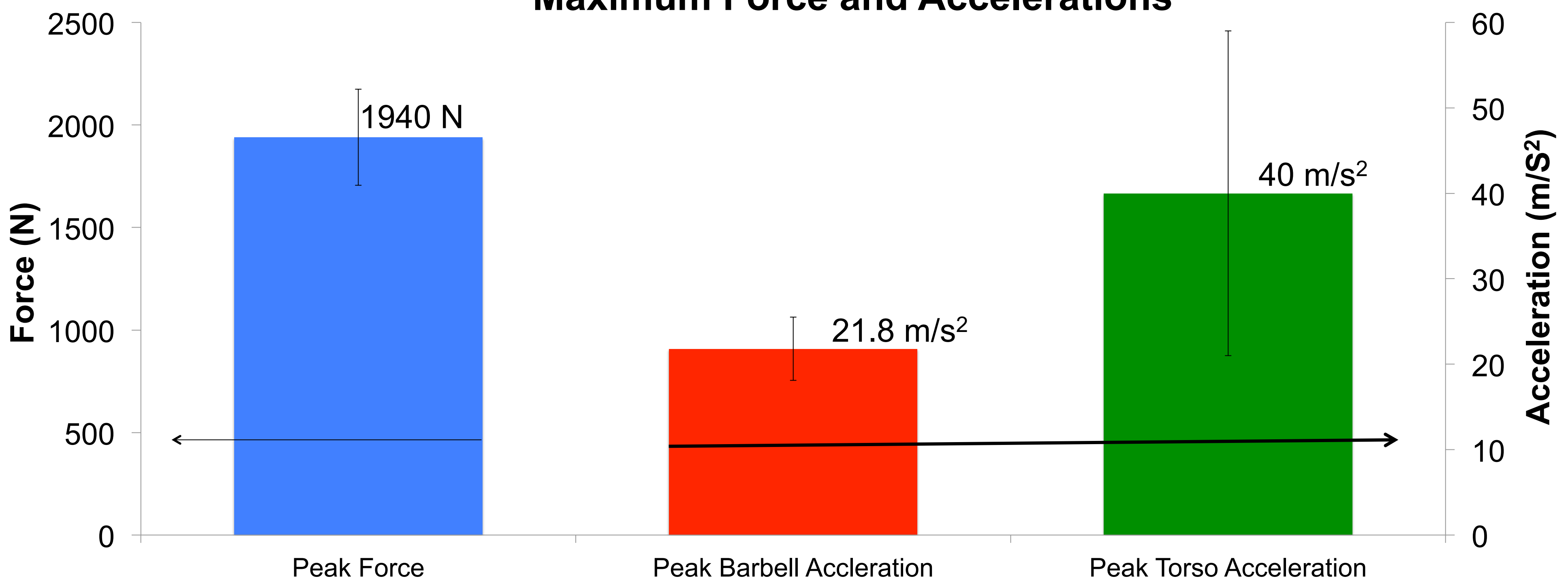
Peak barbell acceleration from literature [1]: **$19.6 \pm 3.0 \text{ m/s}^2$ @ 80% of 1 rep max**

2nd pull power calculated with barbell velocity and measured reaction forces: **$3100 \pm 350 \text{ W}$**
2nd pull power found from literature [2]: **$2591.2 \pm 645.5\text{W}$ @60% 1 rep max**

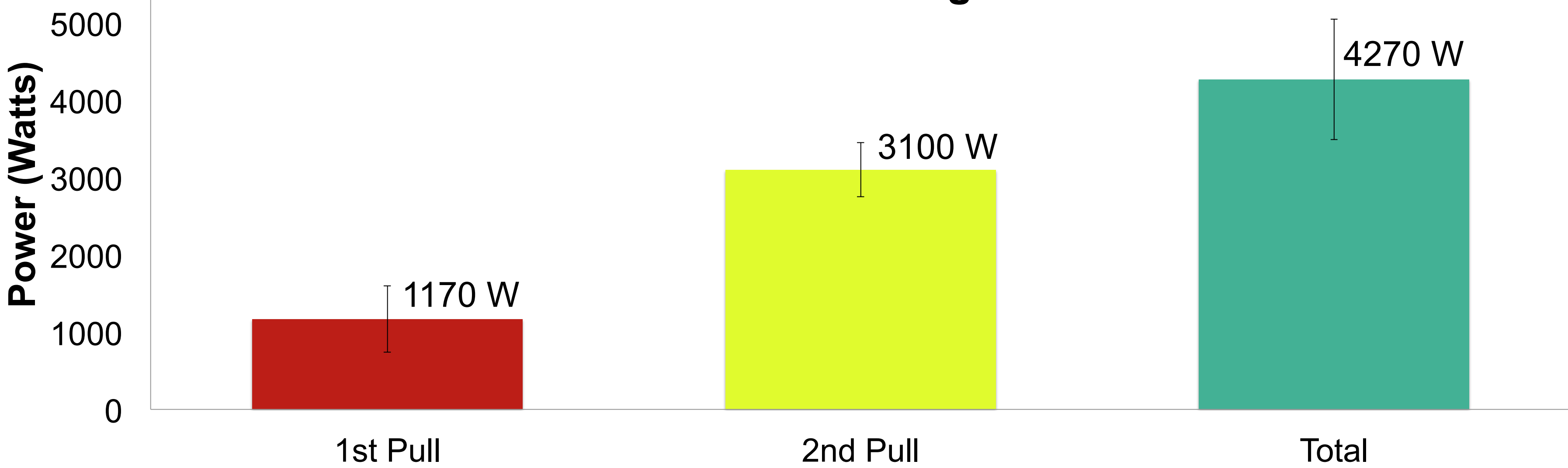
Duration of 1st Pull: **0.6 seconds**
Duration of 2nd Pull: **0.3 seconds**
Barbell Velocity @ 1st Pull: **1.2 m/s**
Barbell Velocity @ 2nd Pull: **1.6 m/s**



Maximum Force and Accelerations



Power Generation During 1st and 2nd Pulls



[2] Comfort, Paul. "Kinetic Comparisons During Variations of the Power Clean", University of Salford, Journal of Strength and Conditioning Research, December 2011.