

The Vise is Right: Grip Force and Memory

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2.671 Measurement and Instrumentation

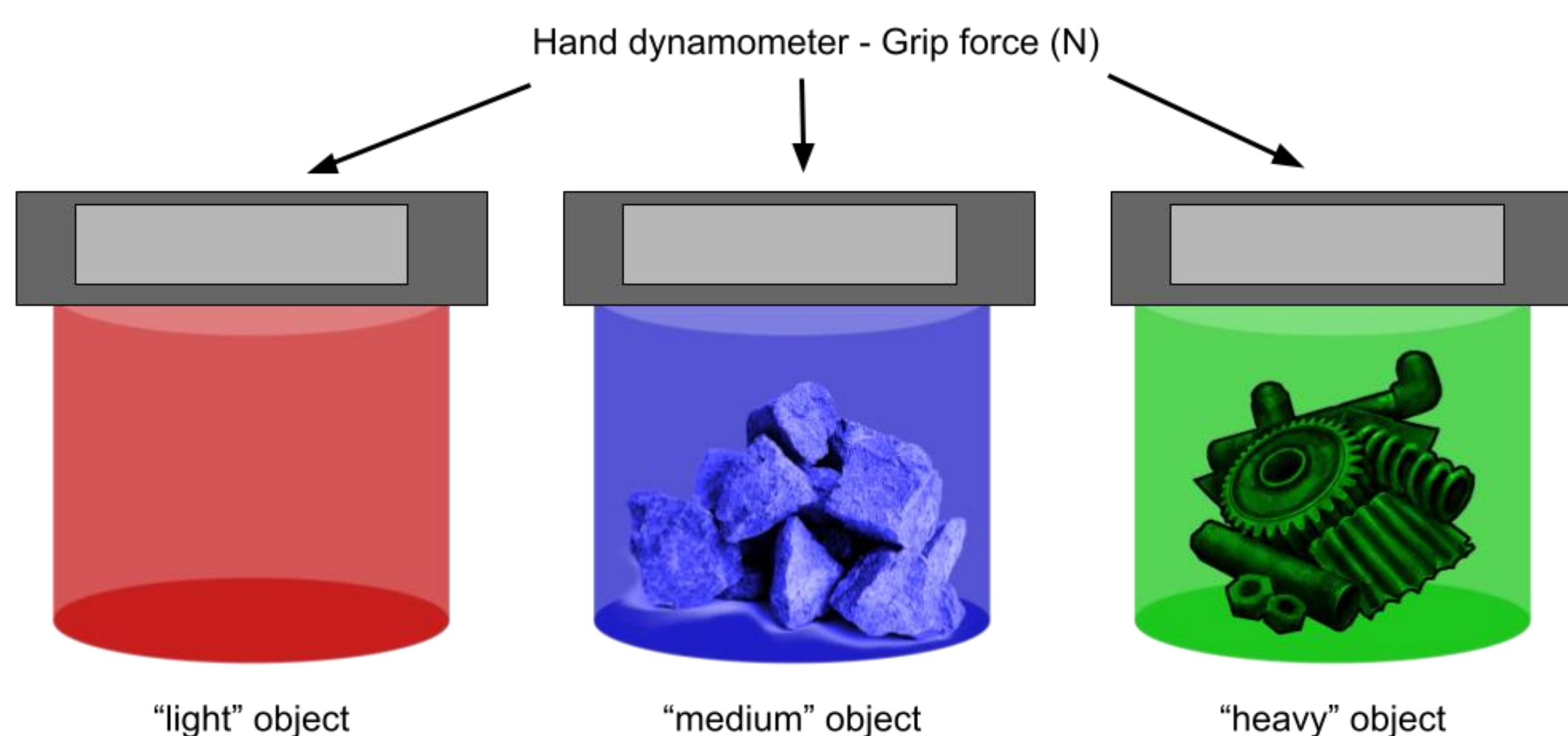
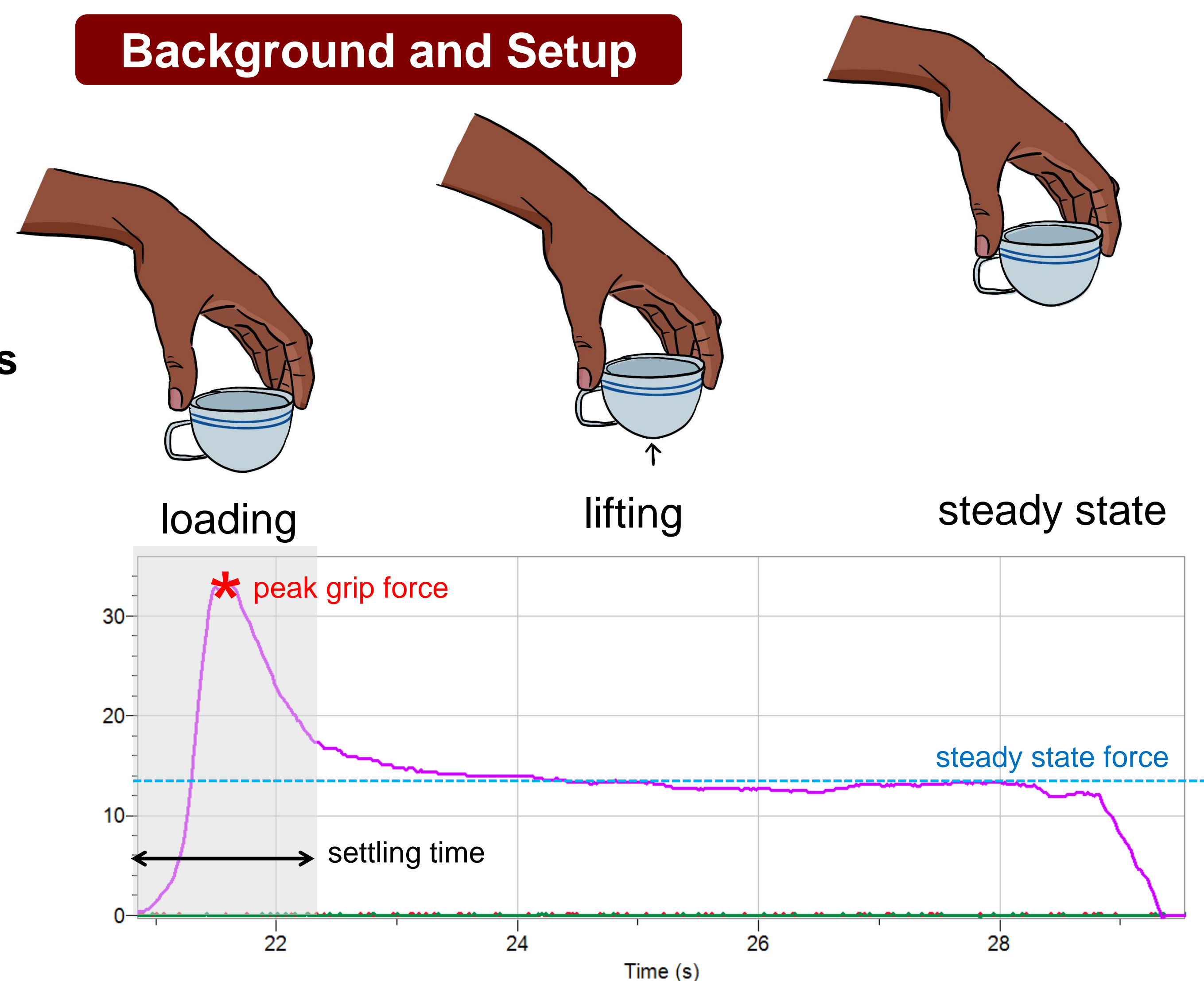
Abstract

Finding out how humans grasp things is useful in robotic manipulation and assistive technology design. For people, grip force can be informed by past experience, allowing muscle control to be refined over repeat interactions. Grip force during lifting was measured on a set of volunteers for various weighted objects. Compared to performance on novel objects, subjects showed a 32% decrease in time to reach a grip force steady state and an additional decrease in the overall grip force applied to hold the object in the air when they lifted a second time.

Background and Setup

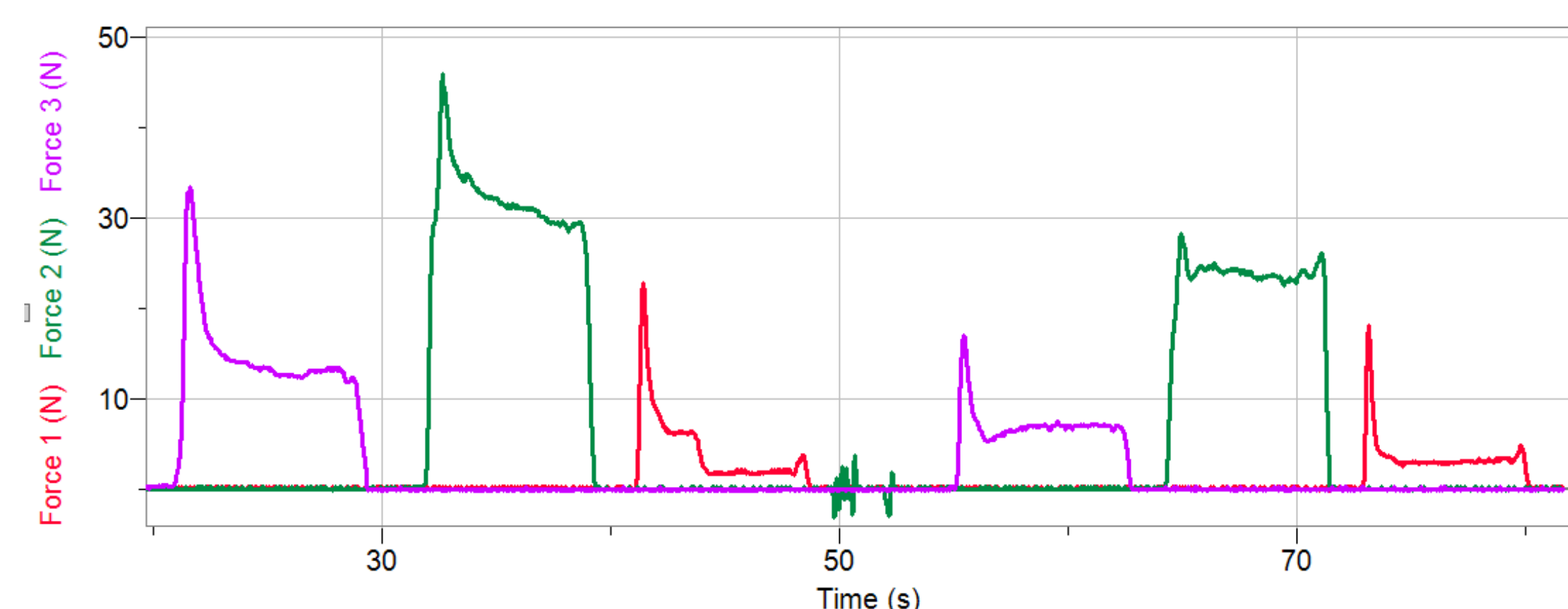
Grip force changes as you lift an object and feel how heavy it is.

Peak force occurs during the loading period and a decrease in force occurs until a steady state force is reached.



Three identical, opaque objects of different weights were presented to 30 volunteers while grip force over time was measured.

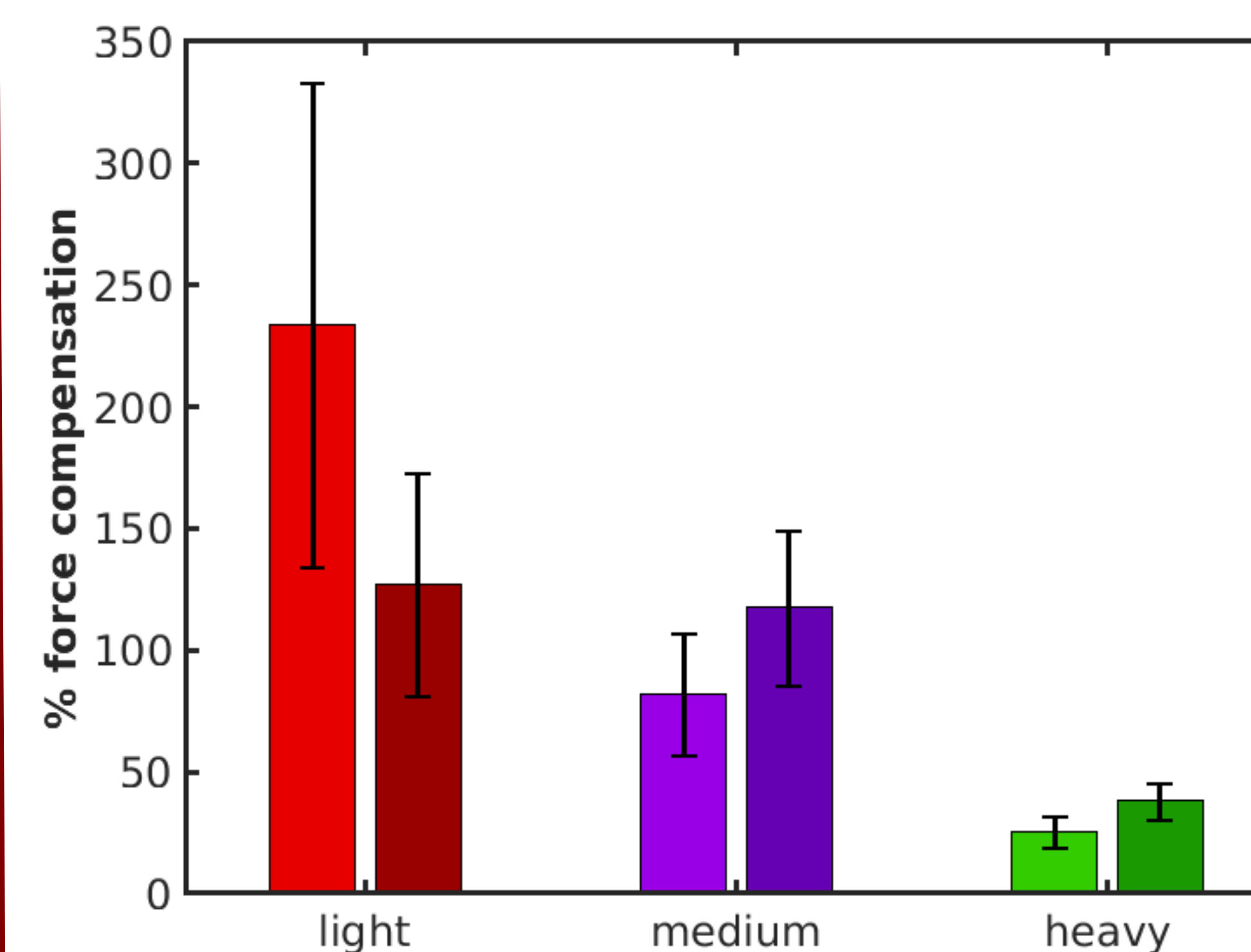
Each object was lifted twice in the span of 1-2 minutes for 6 total grip force curves.



Data Analysis

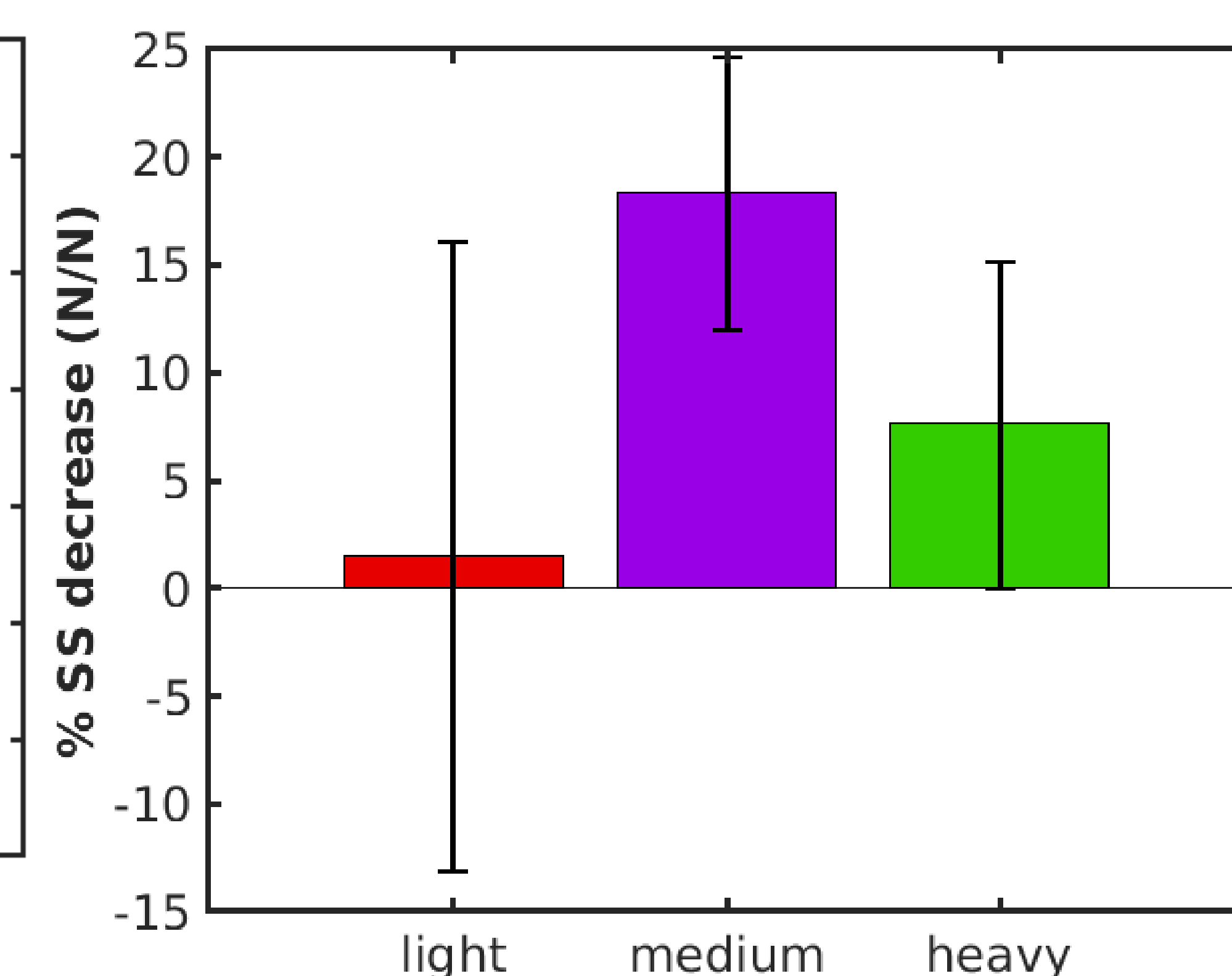
Percent Force Compensation

The force overshoot from grasping to lifting did not significantly improve with memory of the object weight.



Steady State Force Decrease

Between trials, people used less force overall with the most significant decrease in medium objects ($18.3 \pm 6.3\%$)

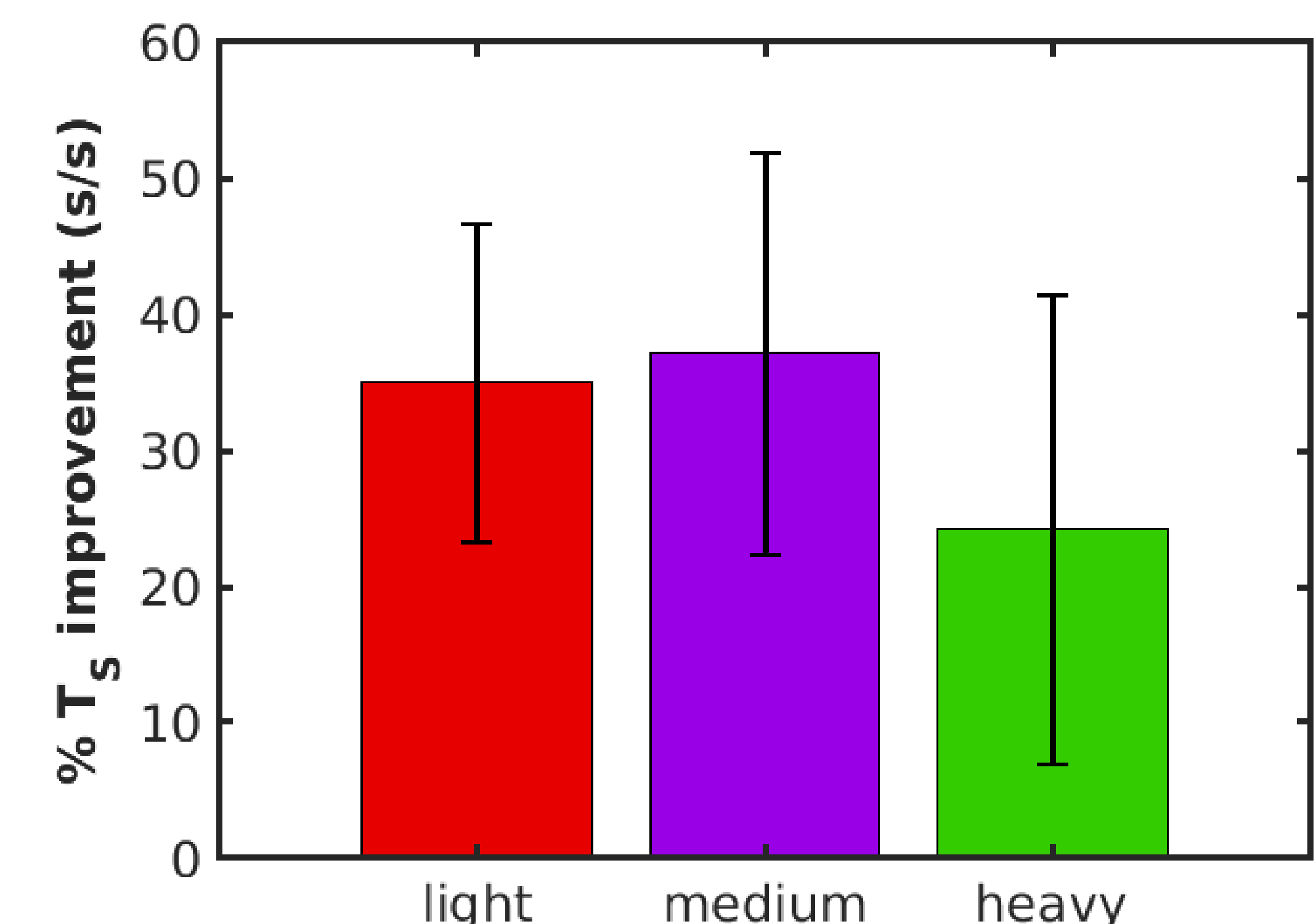


Settling Time Improvement

Time to approximate necessary force improved across categories.

Mean improvement in settling time:

- light: $35.0 \pm 11.7\%$
- medium: $37.1 \pm 14.8\%$
- heavy: $24.2 \pm 17.3\%$



Conclusions

- A statistically significant decrease in time to converge on steady state grip force was shown to occur for lifting medium and heavy objects.
- People overestimate the total required force to lift unknown objects and slowly refine this estimate over repeat trials.
- The magnitude of force compensation between grasping and lifting was not shown to significantly change over the course of one repeat lift trial, although related previous research [1] does show a significant change over the course of several trials (~6).

Acknowledgements

Special thanks to the grad students of the Improbable AI Lab for being such enthusiastic volunteer subjects!

Warm thanks as always to Dr. Hughey, Professor So, and Lauren Chai for their guidance and advice.

References

[1] RS Johansson and G Westling. "Coordinated isometric muscle commands adequately and erroneously programmed for the weight during lifting task with precision grip". Experimental Brain Research. **79** (1988).