Control of an unstable object with dynamic precision grip: Effect of friction

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Abstract

We propose a novel method for measurement of finger forces during a dynamic precision grip.

Two 6-axis load cells and a slender spring were tested under two conditions of friction.

Seven adults participated in the study.

We found no significant differences between the friction conditions, which is contrary to the notion of increased safety margins for static grasp of low friction objects.

Further studies are needed to fully elucidate the differences between stable and unstable

Introduction

Precision grip provides insights into corticospinal motor neuronal connections (1).

Prior human studies of precision grip have focused primarily on isometric tasks using two fingers, which while useful in understanding basic finger force interactions, are limited (2).

In our previous work we have demonstrated the significance of dynamically testing a system to the edge of instability to gain meaningful information about sensorimotor integration in the hand (3).

In this paper we extend our previous work on the dynamical control of one digit to the measurement of dynamic precision grip of instrumented and unstable hand-held objects.

Methodology

Two 6-axis load cells (ATI Instrumentation, Apex, NC) and a slender compression spring (4-5 N) were used.

7 subjects (3 F, 4M, mean age 26 years)

3 trials x 2 conditions [High Friction-sandpaper(220 grits), Low Friction-teflon]

Task- Compress the spring to the point where it will not buckle or slip and maintain for 10 seconds

Results

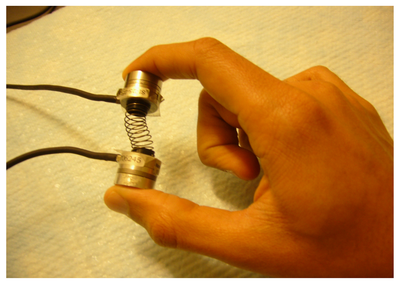
The mean forces of the thumb were 3.61(±0.86, sd) N for low friction and 3.78 (±0.41) N for high friction.

The index finger forces were 3.76(± 0.43) N and 3.69 (±0.9) N for the low and high friction respectively.

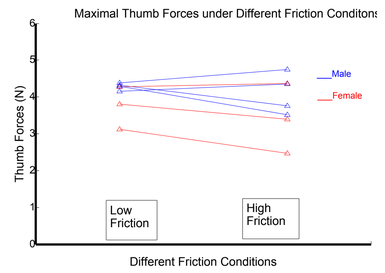
Importantly, in dynamical systems where the imbalance of forces interacts with gravity, inertia, stiffness and viscosity to produce time-varying kinematics, the forces from both fingers need not be equal and opposite, as tends to be the case for static grasp.

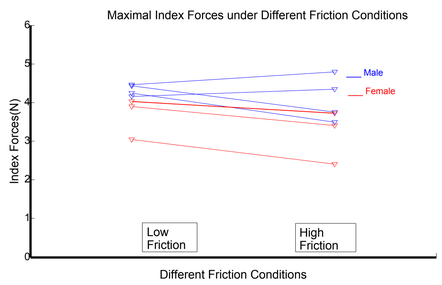
There were no significant differences between the two friction conditions in either force . Interestingly, while it was not the focus of our study, we found a strong trend towards gender differences.

Results



Experimental Setup : 2 6-axis load cells across a slender spring





Maximal thumb and index forces across the friction conditions

Conclusion

In this pilot study we demonstrate the feasability of an unique method for measurement of dynamic precision grip in adults.

Our results indicate that dynamic manipulation does not exhibit an increase in safety margin seen in static grasp under low friction conditions. This is in agreement with our prior study of single digit manipulation (3).

Further studies on finger force interactions are needed using a dynamic precision grip.

References and Acknowledgements

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