RUSK REHABILITATION

NYU Langone MEDICAL CENTER

Eye-hand coordination for adaptation of hand posture to object shape

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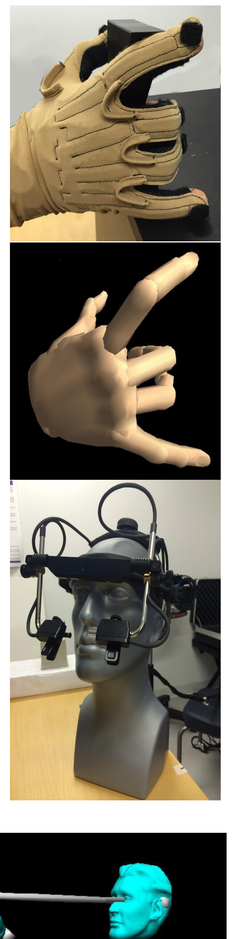
329.05/O41

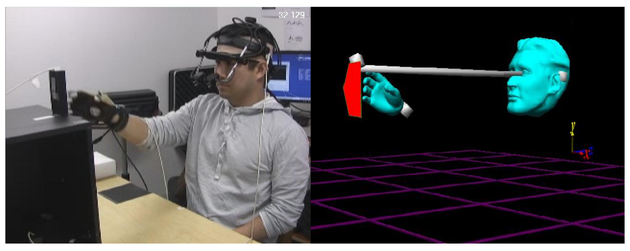
INTRODUCTION

Introduction: Where we look and what we see often determines what we do and how we do it. Visual information about object shape can inform planning of hand posture for efficient grasp. In this study we sought to understand the relationship between gaze location and hand shape when grasping objects of various shapes in neurologically intact individuals. A better understanding of eye-hand coordination during functional tasks will allow us to set benchmarks for comparison with individuals with neurological impairments, who may have impaired eye movements and/or impaired hand function. Our goal is to use this information to develop improved strategies for rehabilitation of eye-hand coordination and restoration of hand function post-stroke.

METHODS

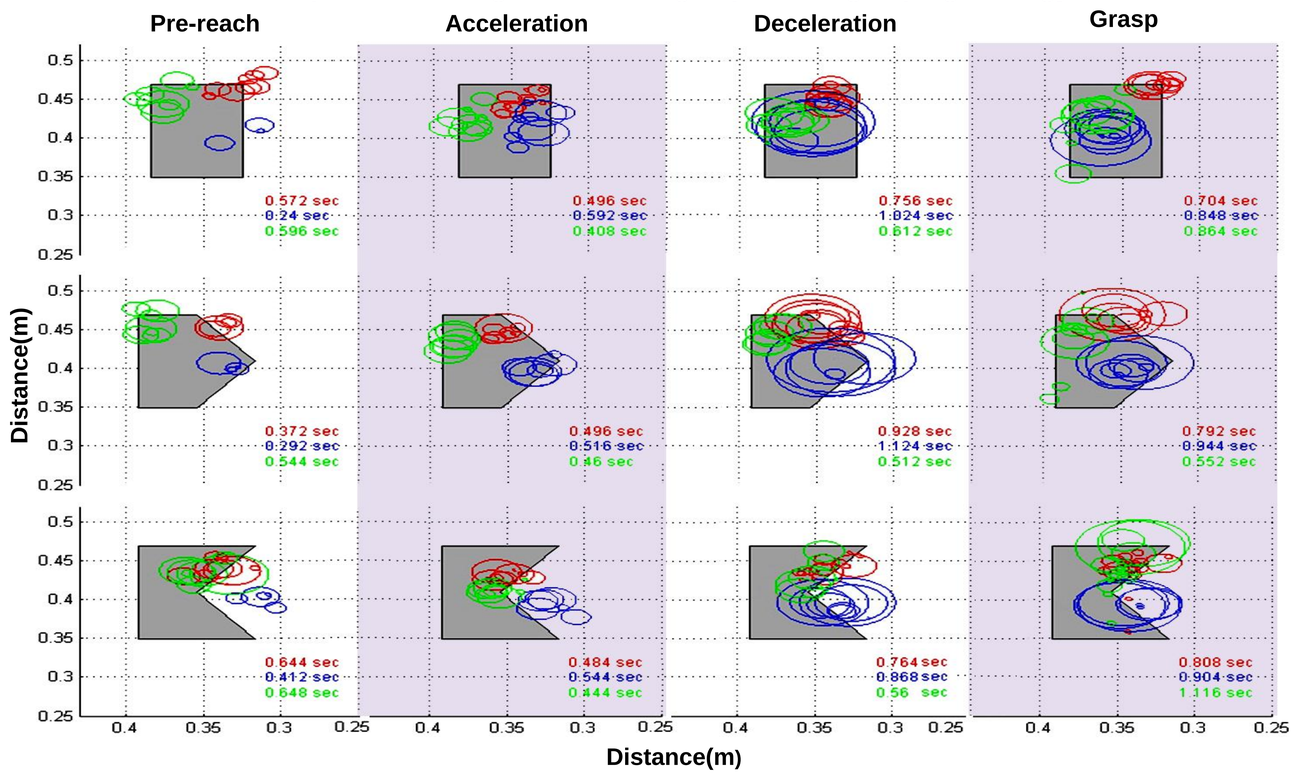
Three neurologically intact subjects between the ages of 26 to 32 participated in this study. All participants were strongly right-handed as determined by a modified version of the Edinburgh Handedness Inventory (Oldfield 1971). The subject shown in red was right-eye dominant, and the subjects shown in green and blue were left-eye dominant as determined by the 'hole in hand' variation of the Miles Test (Miles 1930). The subjects sat at a table with the grasping hand facing palm down in front of them. They then reached toward and grasped a concave, convex and planar object positioned directly in front of them at a distance of 55cm from their eyes, and repeated the task 7 times for each object shape. The focal point of binocular gaze was tracked by a head-mounted eye tracker (Eyelink2 eye tracker SR Research Ltd, Ottawa, Ontario, Canada). The locations of the subject's head and hand were tracked by motion sensors attached to the limb segments (6DOF Ascension sensors, Ascension Technology Corporation Shelburne, Vermont) using The MotionMonitor (Innovative Sports training Inc., Chicago, USA). Adaptation of hand posture to object shape was measured using the Cyberglove (Cyberglove system, San Jose, USA). Data recording was aligned between the devices using a synchronizing pulse generated by a switch.





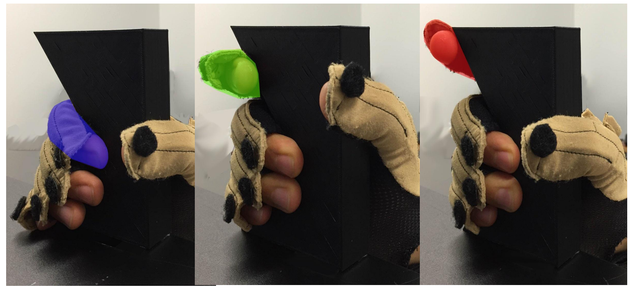
RESULTS

Gaze patterns during evolution of grasp inform grasping strategy

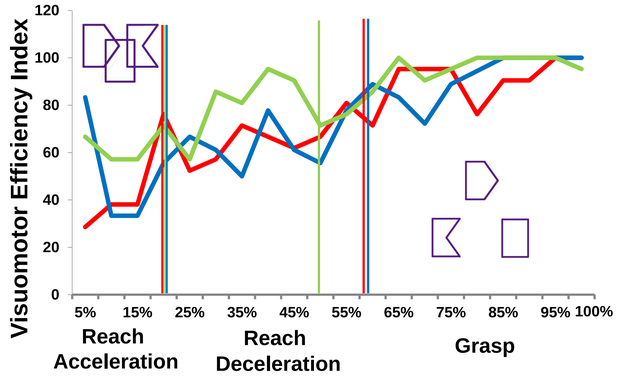


- ***Pre-reach:*** From eye-opening to onset of reach (wrist movement begins); ***Reach Acceleration:*** From onset of reach to peak velocity of the wrist; ***Reach Deceleration:*** From peak velocity of the wrist to end of reach (wrist movement stops); ***Grasp:*** From end of reach to grasp stabilization (finger movements stop). ***Circle sizes show fixation durations. Phase durations for each individual subject are shown in seconds.***

Finger locations at grasp are concordant with the gaze patterns



Gaze patterns may inform timing of hand shaping



The three subjects (represented by the three colors) demonstrated three different strategies for grasping the object despite the same instruction, particularly for the concave object**. (Left figure)**
Subjects grasped each object using the whole hand with the thumb on the planar surface and the 4 fingers spread out along the shaped surface of the object. The extent to which hand posture discriminated the three shapes across the phases of reach-to-grasp was quantified by the visuomotor efficiency (**VME**) index. Subject 3 who gazed at the location of the thumb rather than the index finger discriminated the three shapes earlier during reach-to-grasp. **(Right figure)**

SUMMARY

- **This study evaluated eye position and hand position simultaneously when grasping objects of various shapes.**
- **The gaze patterns for each subject (represented by the 3 colors) show location of gaze on the object before reach and during the various phases of reach-to-grasp.**
- **Pre-reach gaze location anticipated the landing location of the index finger or thumb during grasp, and was most similar for the convex object.**
- **The gaze location is stabilized by the end of the reach acceleration phase, long before the object is actually grasped.**
- **The timing and location of gaze may signify extent of motor planning of hand shape.**
- **Next step is to further quantify gaze behavior on object and hand in a larger cohort of controls and subjects with stroke.**

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ACKNOWLEDGEMENTS

Special thanks to Alvin Tang, Raj Dalsania, Jennifer Stone, James Fung, Qiang Lin and Zena More.
This work is funded by 1R01HD071978-01A1

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