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Lifting without Seeing: The Role of Vision in Perceiving and Acting upon the Size-weight Illusion

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The role of vision in perceiving and acting upon the size-weight illusion

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Introduction

Our expectations of an object's heaviness not only drive our fingertip forces, but also our perception of heaviness. This effect is highlighted by the classic **size-weight illusion** (SWI), where different-sized objects of identical mass feel different weights (Charpentier, 1891) long after any initial errors in the application of fingertip forces have been corrected (Flanagan & Beltzner, 2000).

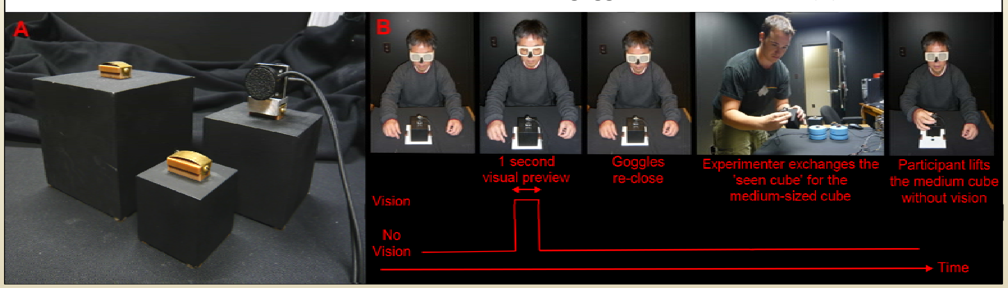
Here, we examined whether our expectations about the weight of an upcoming lift are sufficient to induce the SWI in a single wooden cube when lifted **without visual feedback**, by varying the size of the object seen prior to the lift during a brief preview.

We also measured fingertip forces during lifts of this cube, in order to determine whether the expectations of heaviness associated with the previewed object would affect the application of grip and load forces. We contrasted perceptual and kinetic data with those from a full-vision SWI task.

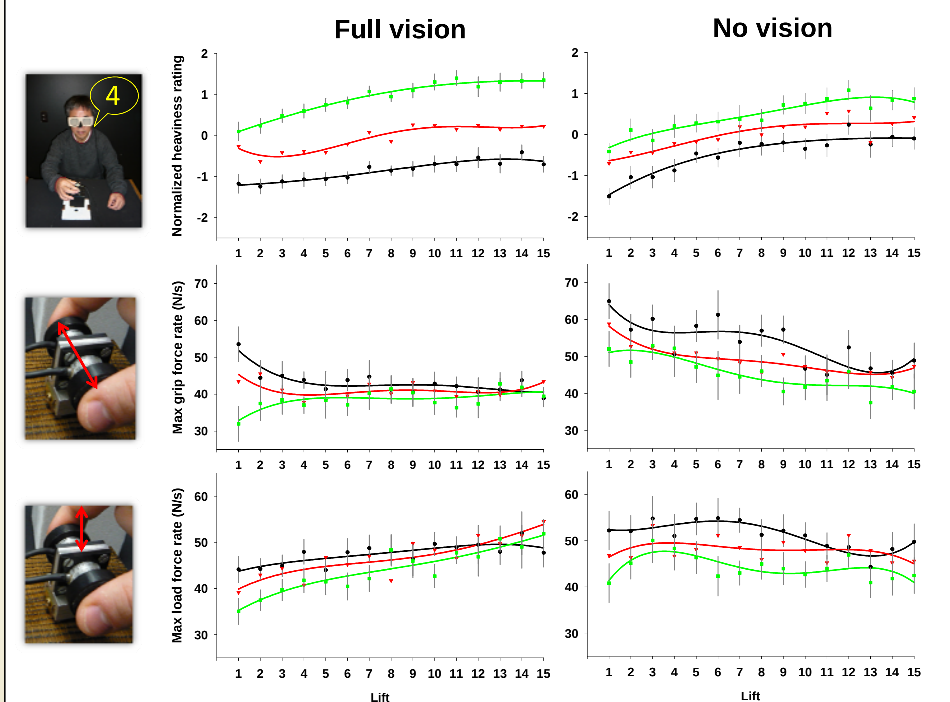
Materials & methods

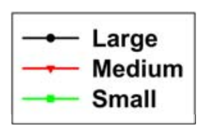
Full vision task: Participants sat in front of a table wearing closed PLATO shutter goggles. The goggles opened at the same time as an auditory go cue, at which point participants reached out and lifted one of the identically-weighted (700g) SWI cubes (A) with their thumb and index finger on the force transducer handle, held it aloft for 3 seconds, and returned it to the starting position. Participants then gave a numerical magnitude estimation of how heavy the cube felt.

No vision task: The shutter goggles opened for 1 second, giving participants a brief view of the (small, medium, or large) cube on the table. The goggles then closed, at which point the experimenter replaced the 'seen cube' with the medium-sized cube - the only object lifted by participants in the no-vision task. The participants, who were not aware that this substitution had taken place, then lifted the medium-sized cube and rated its heaviness, while the goggles remained closed (B).



Results





The small 700g cube felt heavier than the large 700g cube.

Grip and load force rates scaled from the expected weight to the actual (and identical) mass of the cubes.

Seeing the small cube made the medium-sized cube feel heavier than it felt after seeing the large cube.

Grip and load force rates **did not** scale to actual (or perceived) mass of the cubes.

Discussion

The SWI was induced in a **single, unchanging cube** when vision was occluded during lift. This cube felt heavy after seeing a small cube and light after seeing a big cube.

Expectations of heaviness are not only powerful enough to alter the perception of a single object's weight, but also **continually drive the forces** we use to lift the object when vision is unavailable.

Vision is required for the detection / correction of initial force errors, even though these errors are ostensibly haptic. Can vision substitute for impaired somatosensation in clinical populations?

References

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Charpentier A (1891). Analyse expérimentale: de quelques éléments de la sensation de poids. Archives de Physiologie Normale et Pathologique 3:122-135.

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