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Grasping and Lifting Different Materials

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Introduction

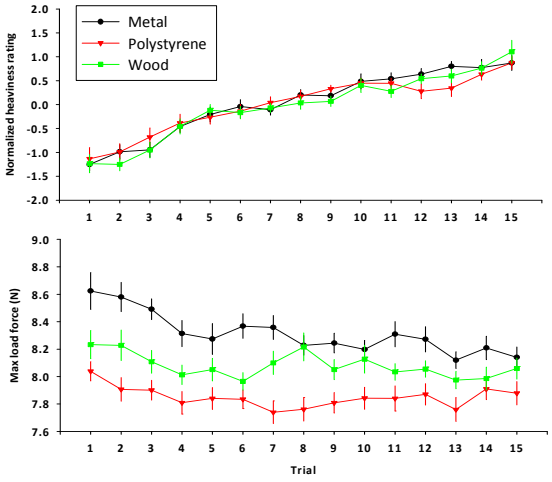
The material from which an object is made can determine how heavy it feels (Seashore, 1899). Interestingly, a metal block that has been adjusted to have the same size and mass as a polystyrene block will feel **lighter** than the polystyrene block. We recently showed that participants experiencing this **material-weight illusion**' (MWI) do not apply forces that match their perceptual experience of heaviness - just like in the size-weight illusion (Flanagan & Beltzner, 2000).

Our previous study showed that forces on early trials were scaled to each participant's **expectations** of how much a particular block should weigh - excessive force was applied to the metal block and insufficient force was applied to the polystyrene block. Forces on later trials scaled to the **real** weight of each block - identical levels of force were applied to all the blocks. MWI persisted **throughout –** the polystyrene block felt the heaviest and the metal block felt the lightest. We followed this finding up with two experiments:

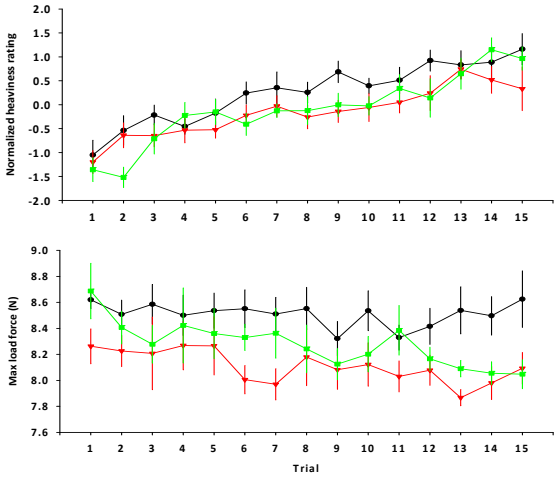
Experiment 1 – different weight, different material: We adjusted the weight of each block slightly in the opposite direction to the illusion, predicting that we would find opposing perceptual and motor responses (e.g., Grandy & Westwood, 2006).
Experiment 2 – different weight, same material: We also removed the visual differences between the blocks, keeping the slight difference in weight, predicting that the dissociation between perception and action would disappear.

Results

Experiment 1 - Different weight, different material (n=29)



Experiment 2 - Different weight, same material (n=9)



Discussion

Experiment 1: Participants were perceptually unable to distinguish between the differently weighted blocks - the MWI was roughly equal to the actual (and opposite) differences in mass. However, participants applied different levels of load force to each block, in line with the actual differences in mass. With visual cues to material available, perception did not match action.

Experiment 2: When the surface visual properties were covered, participants were able to accurately perceive the differences in mass. The removal of the visual cues to weight in Experiment 2 did not alter the application of load force, but made the perception of heaviness converge on the forces applied to each block.

Materials & methods

Participants in lifted specially constructed 10 cm^3 blocks.

- An **aluminium** block, hollowed out to weigh 720 g.
- An **expanded polystyrene** block, filled with lead to weigh 680 g.
- A **wood** block naturally weighing 700 g.

In Experiment 1 the materials were visible; in Experiment 2 the materials were covered with green cardboard.

Experiment 1 **Experiment 2**

Participants sat with their eyes closed while one of the blocks was placed in front of them.

Participants opened their eyes, reached out, gripped the grasp handle attached to the block (containing a force transducer), and lifted the blocks ~5 cm directly upward.

The block was held stationary for several seconds before it was replaced. Participants then gave an unconstrained numerical value to represent how heavy the block felt to them during the lift.

The perceptual measures of heaviness were normalized to a z-score distribution for each participant and maximum load force was calculated from the force transducers.

References

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