Visual-haptic integration: cue weights are varied appropriately, to account for changes in haptic reliability introduced by using a tool.

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Background
- Visual and haptic information should only be integrated when it refers to the same object — the brain must solve a "correspondence problem".
- The visual-haptic correspondence problem could be solved NOT on 'raw' haptic signals, but on remapped haptic estimates, in 'object coordinates' (VSS-2009).
- The brain dynamically rescales haptic estimates, taking account of the geometry of tools. This rescaling is incomplete, however (IMRF-2010, 2010). Variations in tool geometry also affect the reliability of haptic size estimates, because they alter the change in hand opening caused by a given change in object size.
- Here we ask, does the brain appropriately adjust the weights given to visual and haptic size signals when tool geometry changes?

Method
- Measuring visual and haptic reliabilities
  - Vision- and haptics-alone size-discrimination thresholds measured using a 2-IFC task.
  - Aiming to roughly match visual and haptic reliabilities in a size-estimation task.
  - Three tools were randomly assigned.

Measuring size estimates in haptics-alone and vision-plus-haptics
- We measured BIAS in haptics-alone (SH) and vision-haptics (SV) using a size-estimation task.
- Visual and haptic sizes were varied independently.
- The object was located behind an occluder: the tool was invisible during haptic stimulus presentation.

Results
- JNDs, vision-alone
- JNDs, haptics-alone with tool
- JNDs, size estimates, vision-plus-haptics with tool

Conclusions
- When grasping the same object with different tools, the reliability of (and therefore optimal weight for) haptics changed.
- The brain took this into account appropriately, and altered cue weights in a way that was consistent with reliability-based cue weighting.
- The dynamic cue weight change was a good demonstration that haptic sensitivity to object size was affected by the sensitivity at the hand.
- The process of visual-haptic integration accounts for variations in haptic reliability introduced by different tool geometries.