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Does Multi-Sensory Training Aid Visual Learning?

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Motivation

• Expert scientists have perceptual skills which novices lack.

• Novices need to be trained to acquire these skills. For example:

  • Novice radiologists must be trained to visually distinguish breast tumors from other tissue by viewing mammograms.

  • Novice geologists must be trained to visually recognize different types of rock samples.

  • Novice astronomers must be trained to visually interpret stellar spectrograms.

  • Novice biologists must be trained to visually identify different cell structures.

• What is the best way to train people to acquire these perceptual skills?

• **Research Question**: Does multi-sensory training aid visual learning?

Project 1: Learning Visual Cue Reliabilities

• Many visual cues to object depth:

  • Binocular disparities, motion parallax, texture gradients, shading gradients, etc.

• In any context, some cues are highly reliable indicators of depth whereas other cues are less reliable.

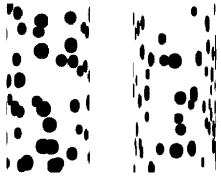
• People assign larger weights to information based on reliable cues and smaller weights to information based on unreliable cues.

• Question: How do people know which visual cues are reliable or unreliable? Can people learn about visual cue reliabilities by comparing visual and haptic (touch) percepts?

Experimental Logic

• Cue-conflict: Visual texture and motion cues indicate different object shapes. Cue-conflict created using computer graphics trick. Stimuli looked natural.

• If haptic percept of shape is consistent with one visual cue but inconsistent with the other visual cue, will subjects learn that the first cue is more reliable and, thus, assign a larger weight to information based on this cue?



Stimuli: Horizontally-oriented cylinders. Visually defined by texture and motion cues. Cylinders varied in their depths.

Virtual reality environment: Subject saw visual stimulus in a head-mounted display. Subject grasped stimulus using a haptic force-feedback device.

Procedure

• Training trial: Subject viewed and grasped a cylinder, and then judged whether the visual and haptic percepts of a cylinder's shape were the same or different.

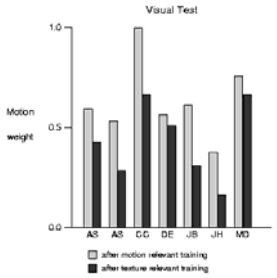
  • **Texture relevant training**: When visual and haptic cues were different, visual texture cue and haptic cue indicated the same shape, whereas visual motion cue indicated an uncorrelated shape.

  • **Motion relevant training**: When visual and haptic cues were different, visual motion cue and haptic cue indicated the same shape, whereas visual texture cue indicated an uncorrelated shape.

• Subject first performed one type of training and then the other type of training. Order of training was counter-balanced across subjects.

• After each type of training, subject performed test trials to evaluate how much he or she used the visual texture cue and the visual motion cue when visually judging the depth of a cylinder.

Results

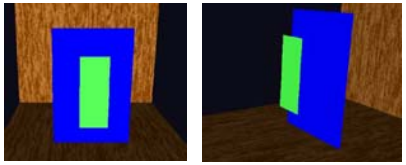


All subjects used the visual motion cue more after motion relevant training than after texture relevant training, and used the visual texture cue more after texture relevant training than after motion relevant training.

Conclusion: Subjects can compare their visual and haptic percepts to learn about the relative reliabilities of different visual cues, and can adapt their use of each visual cue accordingly.

Project 2: Visual Cue Recalibration

Question: Can people use inconsistencies between visual and haptic percepts to recalibrate their interpretations of an individual visual cue?



Stimuli: two planar surfaces (green and blue), one in front of the other. The only reliable visual cue to the distance between the surfaces was a visual stereo cue.

Procedure

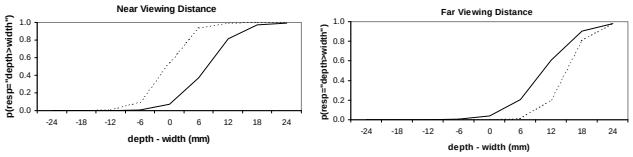
• Training trial: Subject viewed the two surfaces, and judged whether the depth between the surfaces was greater than the width of the front surface. Next, subject grasped the surfaces, and again judged whether the depth between the surfaces was greater than the width of the front surface.

• Cue-conflict:

  • when viewing distance was small (the surfaces were near the subject): depth indicated by haptics > depth indicated by vision

  • when viewing distance was large: depth indicated by haptics < depth indicated by vision

Results



Solid line: visual pre-test (before training)

Dotted line: visual post-test (after training)

Graphs show data for 1 subject. 6 of 7 subjects showed this pattern of results.

Conclusion: Subjects can recalibrate their depth-from-visual-stereo estimates based on inconsistencies between visual and haptic percepts.

Collaborators

Project 1: Joseph Atkins, Jozsef Fiser

Project 2: Joseph Atkins, David Knill