

Representing Objects when Interacting with the World: from Behaviour to the Brain



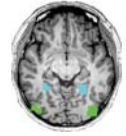
Randy Flanagan



Behaviour



Jason Gallivan



Brain

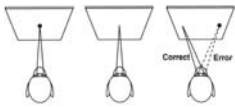


Motor Control Research

Looking at targets

Pointing to targets

Reach to Grasp Objects



Real-world action tasks



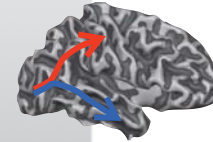
Lifting

Two Visual Streams Model

Goodale & Milner



Dorsal Stream:
Vision for action



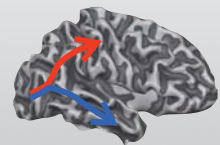
Ventral Stream:
Vision for perception

Two Visual Streams Model

Goodale & Milner



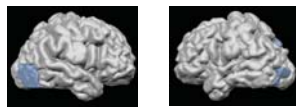
Dorsal Stream:
Vision for action



Ventral Stream:
Vision for perception

Patient DF

- Hypoxia from carbon monoxide poisoning
- Diffuse cortical damage with large lesions in the ventrolateral occipital region, sparing VI



Area LO lesion

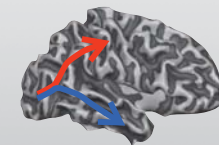
- Most salient symptom was *visual form agnosia*
- Clinical and psychophysical testing was largely in the normal range

Two Visual Streams Model

Goodale & Milner



Dorsal Stream:
Vision for action



Ventral Stream:
Vision for perception

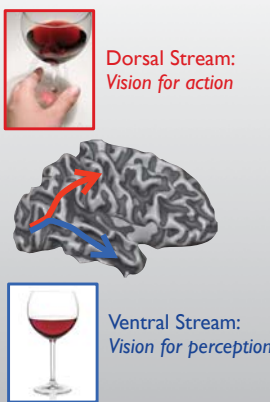
Patient DF

Dissociations between Action and Perception



Two Visual Streams Model

Goodale & Milner

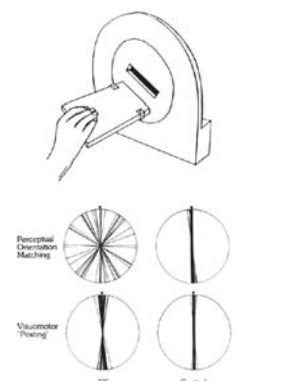


Dorsal Stream:
Vision for action

Ventral Stream:
Vision for perception

Patient DF

Dissociations between Action and Perception




Perceptual Orientation Matching

Visuomotor Training

DF Control

Two Visual Streams Model

Goodale & Milner

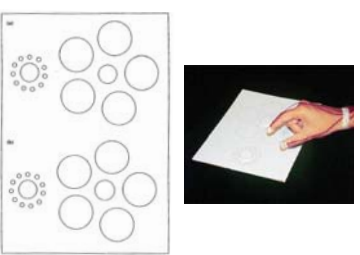


Dorsal Stream:
Vision for action

Ventral Stream:
Vision for perception

Patient DF

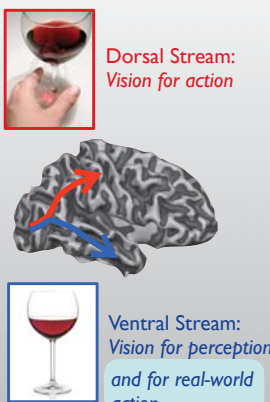
Dissociations between Action and Perception



Aglioti, DeSouza, Goodale 1995

Two Visual Streams Model


Goodale & Milner



Dorsal Stream:
Vision for action

Ventral Stream:
Vision for perception and for real-world action

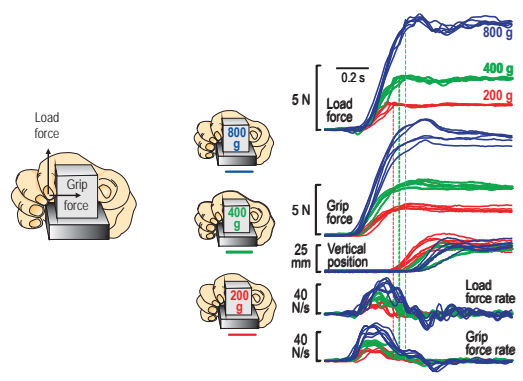
What about object manipulation and memory for weight?



light heavy

Learned associations

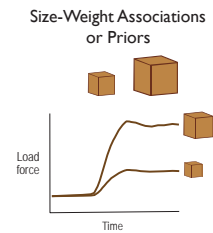
Weight prediction is critical in dexterous object manipulation



Johansson & Westling, Experimental Brain Research, 1988
Gordon et al., Experimental Brain Research, 1991

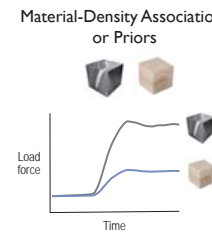
Memory Representations of Object Weight

Size-Weight Associations or Priors



Johansson & Westling, *Exp Brain Res*, 1988
Gordon et al., *Exp Brain Res*, 1991

Material-Density Associations or Priors



Buckingham et al., *J Neurophysiol*, 2009

2-4 Condition


110 trials

80 % 20 %
catch

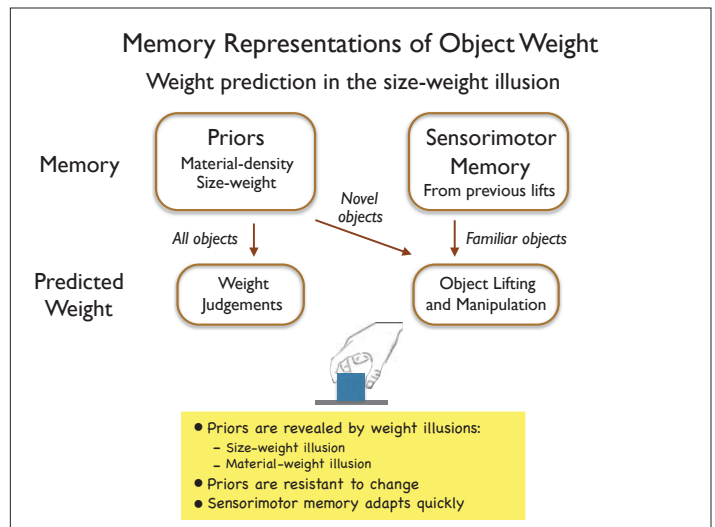
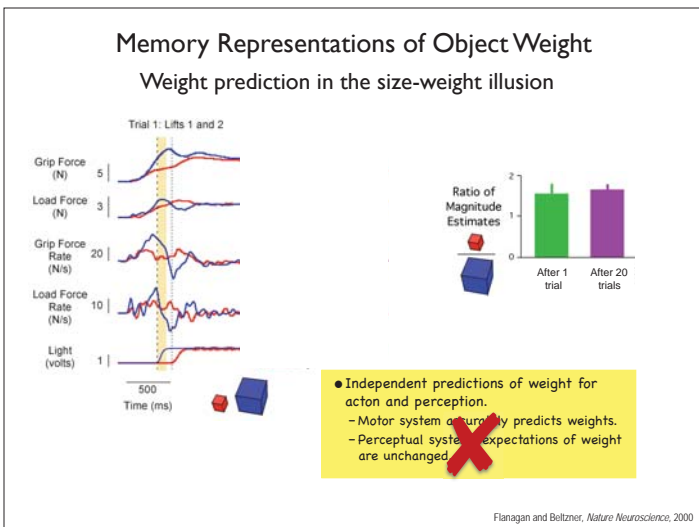
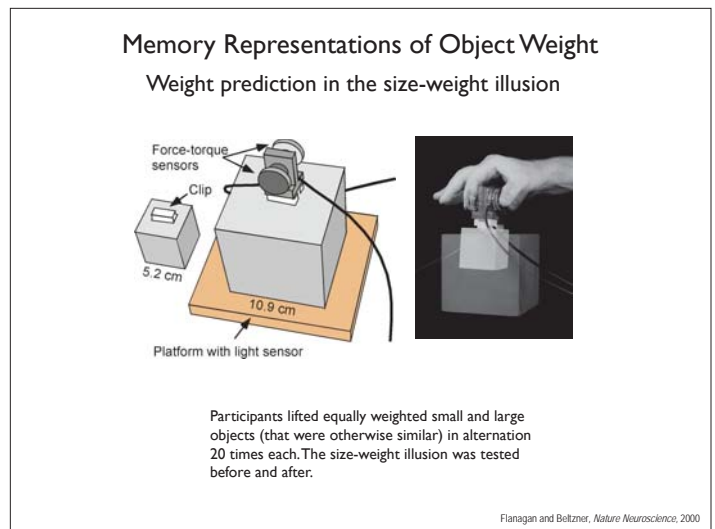
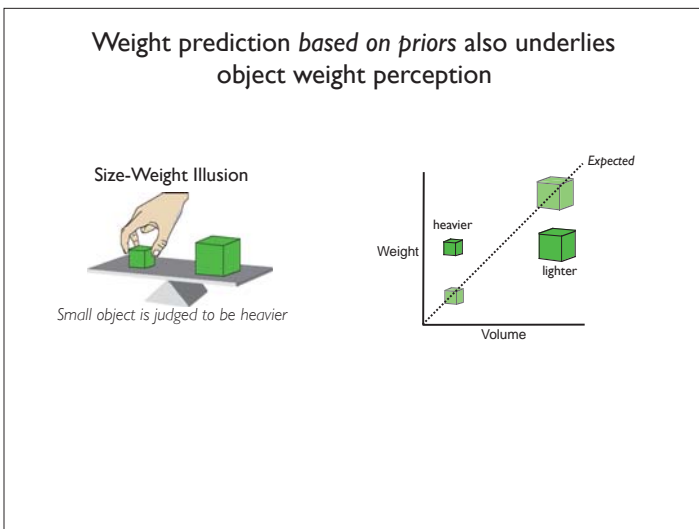
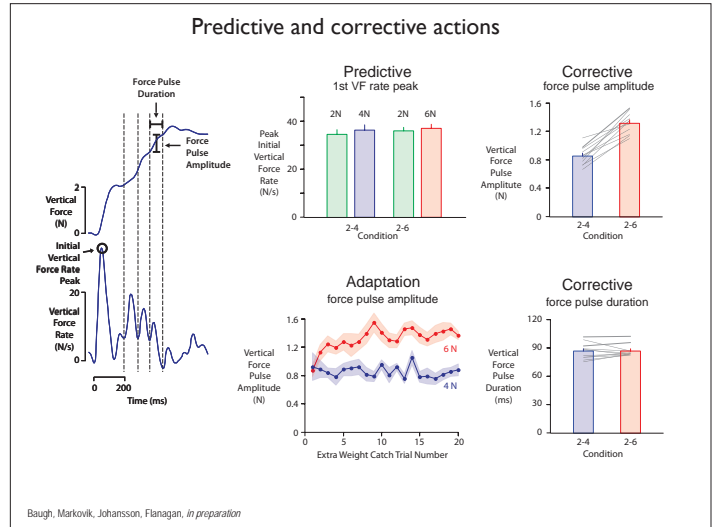
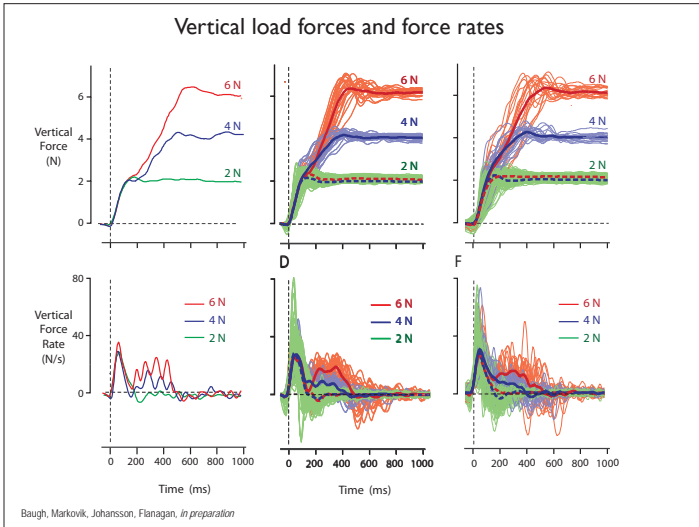
2-6 Condition

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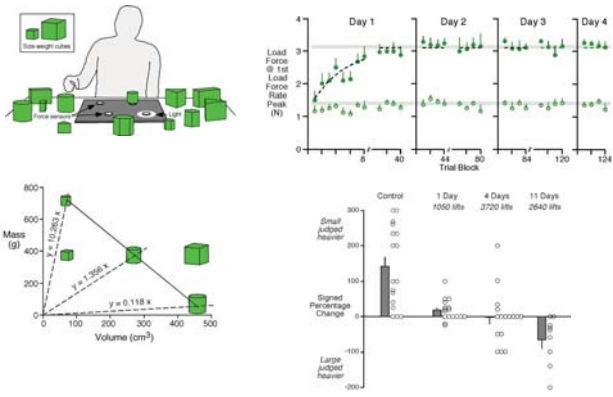


Baugh, Markovik, Johansson, Flanagan, *in preparation*

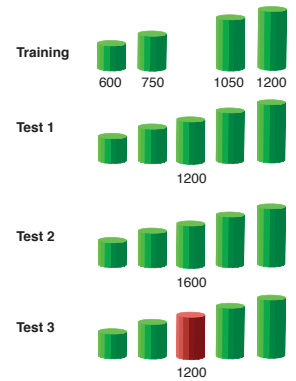
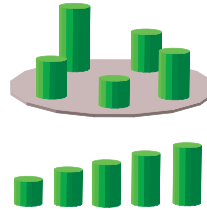
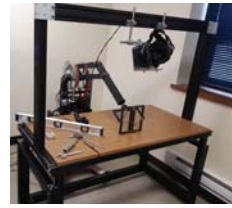


Memory Representations of Object Weight

Weight prediction in the size-weight illusion



Flanagan, Bitner & Johansson, *Current Biology*, 2008

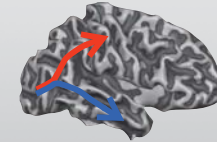


Two Visual Streams Model

Goodale & Milner



Dorsal Stream:
Vision for action



Ventral Stream:
Vision for perception
and for real-world action

What about object manipulation and memory for weight?



light

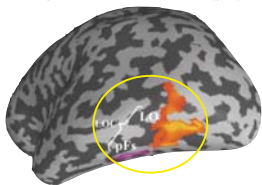
heavy

Learned associations



Memory Representations of Object Weight

Lateral occipital complex
lateral occipital area (LO)
posterior fusiform sulcus (pFs)



From Hasson et al., 2004, *TICS*

Contrast:



General purpose object-processing region:

- Size
- Shape
- Location

High-level object representations:

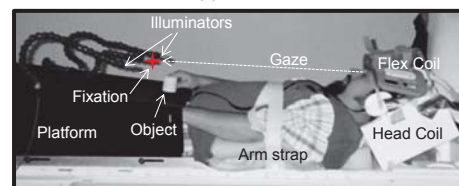
- Luminance
- Texture
- Motion
- Grayscale or line-drawing
- Haptics (unseen)

What about object properties—like weight—that are not directly available to vision?

For review see Grill-Spector and Malach, 2004, *Annual Reviews Neuroscience*

Memory Representations of Object Weight

Apparatus



Gallivan, Cant, Goodale, Flanagan, *Current Biology* 2014

