Thinking with One's Body in Ship Navigation

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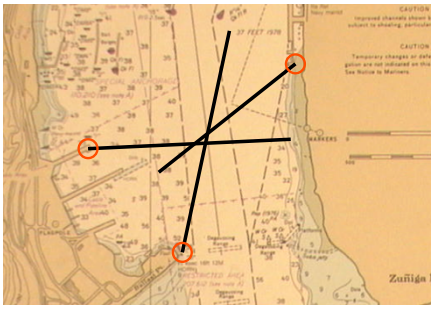
Plan of the talk

- In many domains of activity experts manifest thinking through the movement of their bodies and their tools
- Embodied thinking entails complex integrated multimodal representations
- An Aha! insight in ship navigation
- Re-examining the Aha! as embodied thinking
- Elements of multimodal experiences can combine in ways that make insights possible

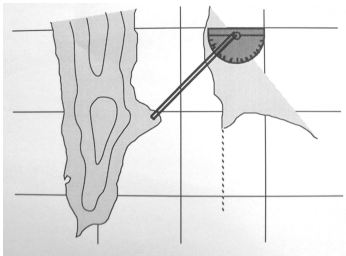
Navy Ship

Ship's Navigation Team

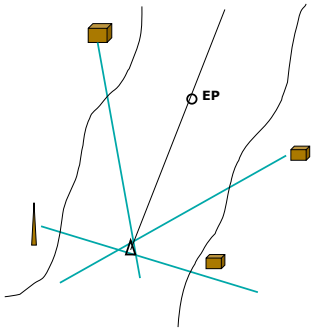
Position Fixing by Visual Bearings



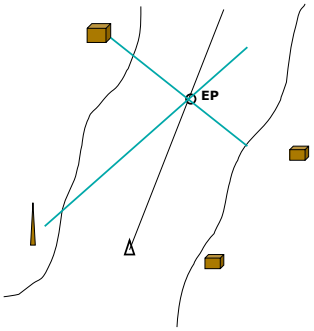
Hoey in Coordination with the Chart



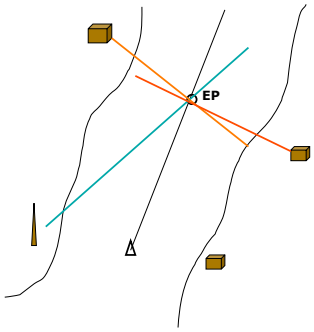
Position Fixing by Visual Bearings



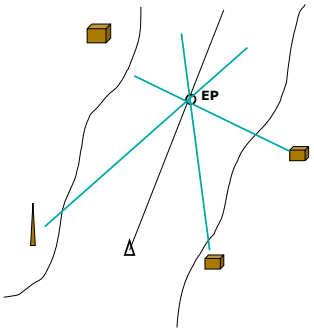
Position Fixing by Visual Bearings



Position Fixing by Visual Bearings



Position Fixing by Visual Bearings

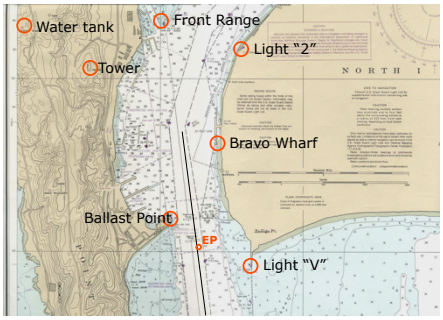


Enacting LOPs in Gesture

Interpreting events as instances of theoretical objects

- Events
  - Crew interaction
  - Gestured virtual LOPs
  - Angles of intersection
- Theory
  - choice process
  - representations
  - choice criteria

Seeing the EP and landmarks



Representations in the brain when locating objects

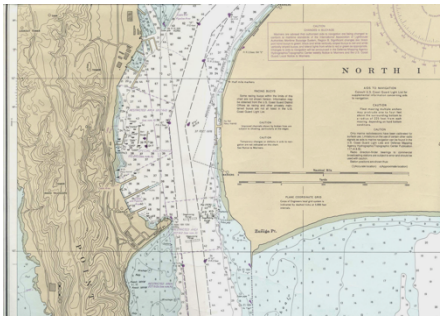
- Memory for LMs
- Visual
  - Retino-centric
  - Head-centric
  - Body-centric

Representations in the brain when gesturing on the objects

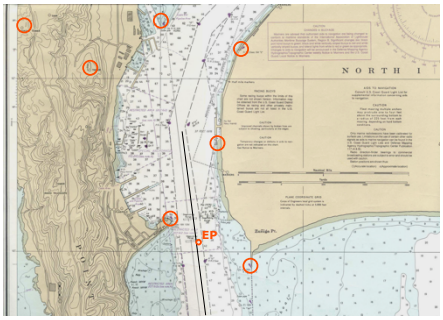
- Memory for LMs
- Visual
  - location
    - Retino-centric
    - Head-centric
    - Body-centric
  - Motion
  - Velocity
  - Direction
    - Retino-centric
    - Head-centric
    - Body-centric
- Motor system
  - Location
  - Velocity
  - Direction
- Somatosensory
  - Location
  - Velocity
  - Direction

The Mind

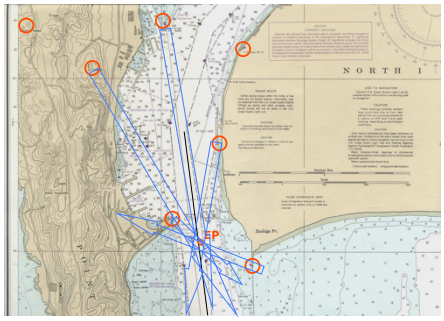
San Diego Harbor Chart



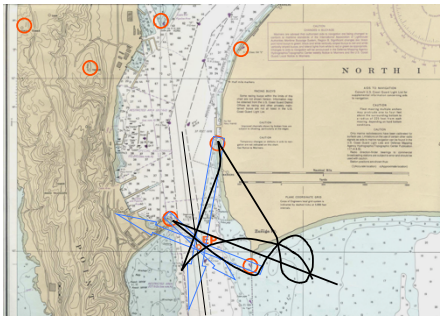
Estimated position and nearby landmarks



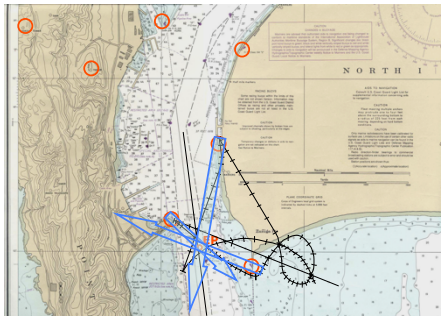
Potential lines of position



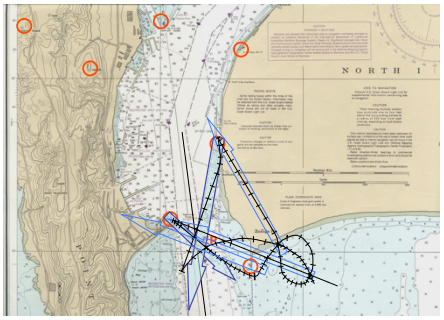
The trajectory of BR's gesture



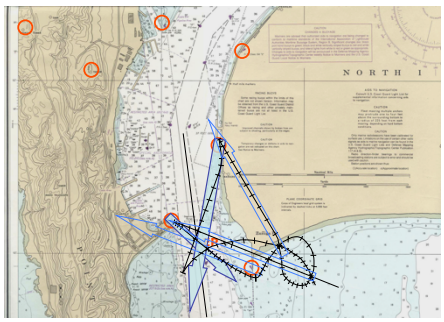
Velocity profile of the gesture



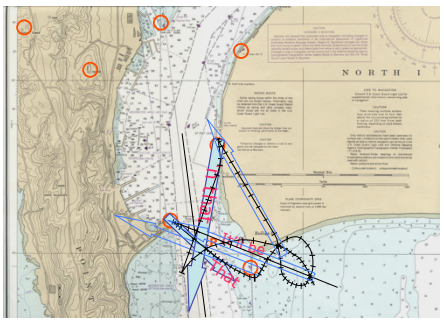
Linear segments of gesture



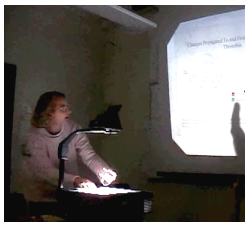
Altitude of gesture above the chart surface



Co-gesture speech

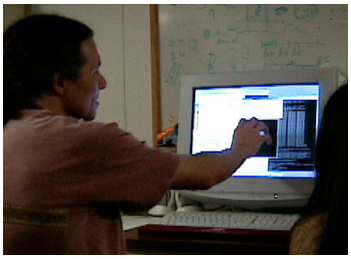


Using gesture over static graphics to create virtual objects that can be manipulated: 1. The Thrombin Hand



Amaya Becvar

Using gesture over static graphics to create virtual objects that can be manipulated: 2. Rotating a brain

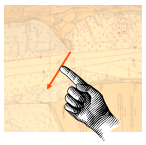


Morana Alac

Integration and mutual elaboration of multiple modalities

Visual Imagery

Motor Enactment



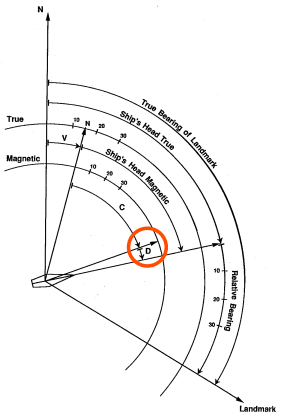
"It'll be that and that"

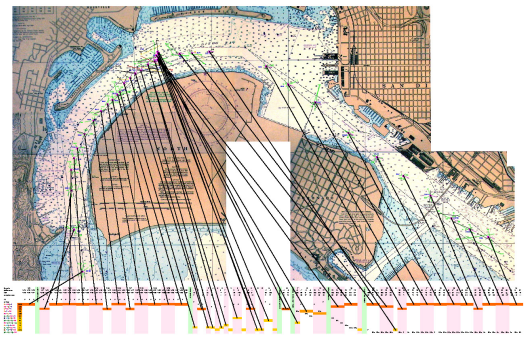
Emergency Situation: loss of fuel flow to main steam boiler

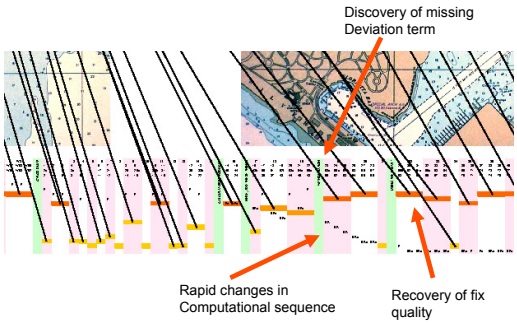
- Ship Control
  - Loss of propulsion - can't stop
  - Decreased steering response
  - Loss of electrical power throughout the ship
- Navigation
  - Loss of main gyrocompass system
  - Loss of ability to directly measure true bearings of landmarks
  - Need to compute True Bearings from Relative Bearings

Corrections to be applied

TBLm = ((C+D)+V)+RB





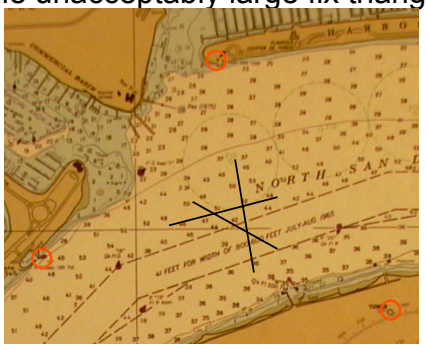


Aha! Insight

Symbol systems don't hold the answer

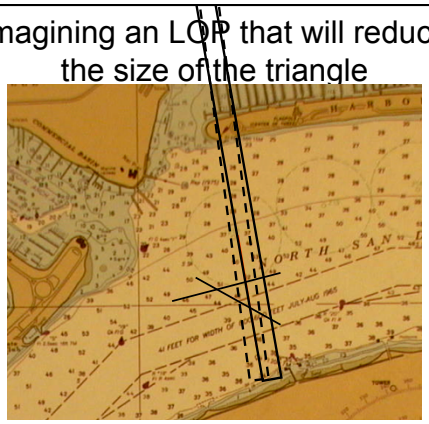
- Talk leading up to the insight expresses frustration at the poor quality of the fix. "I keep getting these monstrous friggin' goddamn triangles and I'm trying to figure out which one is fucking off."
- Computational sequences leading up to the insight simply lack the missing deviation term.

The unacceptably large fix triangle

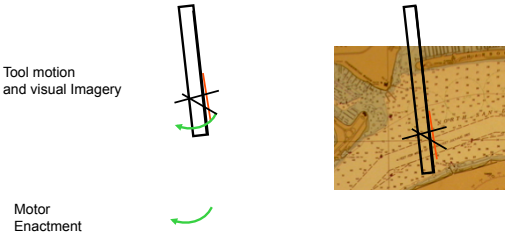


Imagining an LOP for LM1 that shrinks the triangle

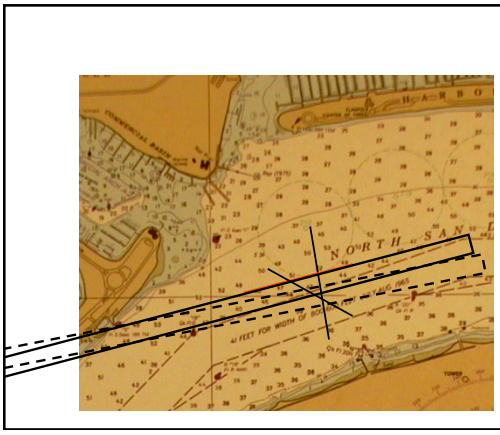
Imagining an LOP that will reduce the size of the triangle



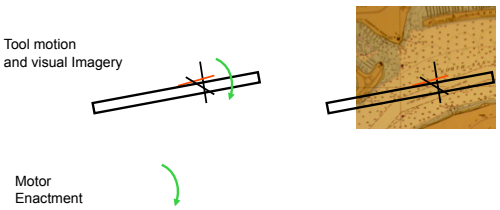
The embodied experience of imagining the first LOP



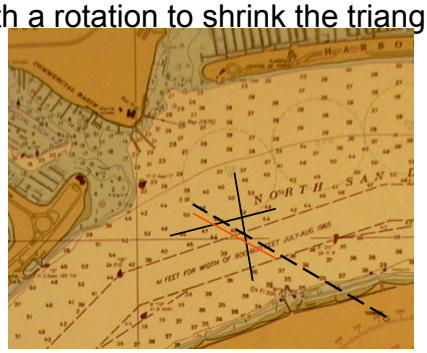
Imagining an LOP for LM2 that shrinks the triangle



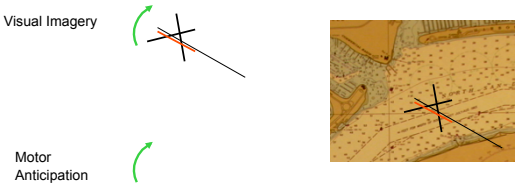
The embodied experience of imagining the second LOP



Imagining 120º bearing to tower with a rotation to shrink the triangle

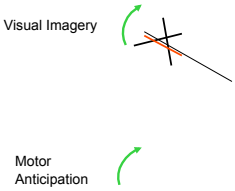


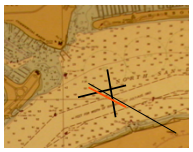
The embodied experience of imagining the third LOP



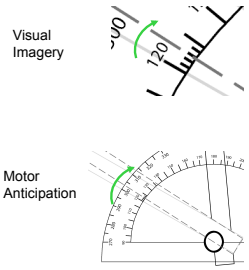
Moving the hoey arm toward the 120 degree mark

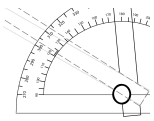
In the context of imagining displacement of the third LOP





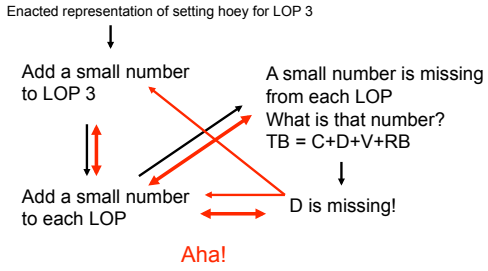
Moving hoey arm to set 120º in the context of imagining a small clockwise displacement





"I know what he's doing"

Where is the Aha!



Multi-modal Imagination

- Integrated visual and motor imagery of clockwise displacement of hoey arm created in the manipulation of the hoey arm while trying out provisional LOPs
- Combined with the visual experience of the hoey scale while focusing on the setting of the hoey angle to plot the third LOP
- Produces a visualization of a numerically larger bearing.
- Adding a small amount to each bearing is what the missing deviation term would do. This is when the plotter has his insight.

Cognitive Implications of Embodied Thinking

- Bodily motion acquires meaning in relation to culturally organized environment
- Multimodal experiences are integrated wholes

In Multi-modal Experiences

- When the content of modes overlaps, the stability of representations is enhanced and reasoning is facilitated.
- When the content of modes differs in complementary ways, new combinations of content are created and new insights may be “seen”.