“Egocentric Localization: Normal and Abnormal Aspects”

Kenneth J. Ciuffreda, O.D., Ph. D.
Diana P. Ludlam, B.S., C.O.V.T.
Naveen K. Yadav, B.Sc.(Optom.), M.Sc.
“Language should not obscure the concept”
(KJC)
Discuss 3 areas:

1. Definitions and basic concepts
2. Four critical laboratory experiments
3. Clinical assessment of egocentric localization (EL) in ABI patients
Definitions and basic concepts
Spatial Sense

“The means by which an organism establishes a stable, constant relationship with its surroundings” (Reading, 1983)
Spatial Sense:

• Orientation – The information needed to know where we are with respect to our environment (e.g., equilibrium mechanisms).

• Localization – The information needed to know where objects are with respect to the individual.
  - oculocentric
  - egocentric
Oculocentric

- eye – based
- fovea is the center of the coordinate center
- objects are referenced with respect to the fovea
- monocularly-based
Egocentric

- body – based
- center of the trunk along the body midline is the center of the coordinate system in normals
- objects are referenced with respect to the body
- binocularly-based
- subjective straight-ahead is within +/- 2 degs of objective zero in normals, so it is very accurate
To specify precisely an object’s egocentric localization, you need 3 parameters:

1. Meridian
2. Eccentricity
3. Absolute distance

∴ it is a POLAR – based coordinate system.
(e.g., “the object is over there up and to the right about 20 feet away”)
In Acquired Brain Injury (ABI) patients, especially CVA, egocentric localization (EL) can sometimes be disturbed by the brain injury, especially if the right posterior parietal cortex region is damaged.

:. objective is not equal to the subjective sense of straight ahead direction.

:. they have “abnormal egocentric localization” (AEL) (aka VMSS), mainly laterally-biased into the ‘seeing’ hemi-field.

:. produces “cue conflict” leading to visuomotor problems (“out of synch with their environment”)


Compensatory yoked prisms can be used to reduce this subjective versus objective directional mismatch by optically displacing the visual field.
Without Yoked Prisms:
With Yoked Prisms:
Three conditions are frequently associated with AEL:

1. hemianopia ("physiological")

2. visual neglect ("perceptual")

3. "post – trauma vision syndrome" ("oculomotor, attentional, and cognitive")
Four Critical Laboratory Investigations
1. Werner et al (1953)
   - basic psychologists
   - first to use proprioceptively-based, straight-ahead pointing task in normals
   - “apparent median plane” criterion

   - clinical neurologist
   - first to test egocentric localization in the laboratory in brain – injured patients (e.g., stroke with neglect only)
   - found large (15 degrees) deviations to the right, $. AEL$
3. Rossetti et al. (1998)

- experimental psychologists

- developed prismatic, visuomotor–based, therapeutic intervention in patients with stroke, visual neglect, and AEL.

- 2 hour training period with 17.5 pd bases – left yoked prisms without visual feedback

- resulted in a central shift of their AEL

- retained for several hours; persisted for days or weeks per other studies.
4. Ciuffreda research group (2001)

— developed small, portable device to assess AEL in the clinic and clinical research environments

— found smaller magnitudes of AEL than Karnath, but had a more diverse CVA patient population

— this information was used in the final yoked prism prescription.
A. Inside View

Horiz. Knob

M1

G

M2

Grid
B. Side View

- Horiz. Knob
- Laser
- M1
- M2
- M3
- G
- E
Our Hypothesis

Damage to right posterior parietal cortex

Produces a systematic directional error in the body’s spatial frame of reference

 Therapeutic yoked prism adaptation produces a prism aftereffect that transiently makes AEL more normal/central (+ the compensatory yoked prisms reduce the subjective versus objective directional mismatch)

The aftereffect persists as it is beneficial, that is, it reduces the subjective versus objective directional mismatch
Clinical ways to assess egocentric localization
Observation of patient’s behavior
(D. Ludlam)

• assess posture in reception chair

• assess gait, posture, balance, leaning, “drift”, etc., as they walk down the hallway to the examination room
Face-to-face procedure
(D. Ludlam)

• Dr. and patient face each other at eye level

• patient “points” to Dr.’s nose with their nose.

• assess for gross misalignment, head turns, tilts, etc.
Wand procedure
(W. Padula; modified by D. Ludlam)

• patient follows with their eyes a horizontally moving wand (head stationary) in an uncluttered room/wall.
• indicates when wand seems to be in front of their nose.
• repeat vertically and indicate when its in line with their eyes
• depict results on a schematic face
• add yoked prisms to center wand on their nose
Hallway procedure
(I. Suchoff)

• patient gazes down a long uncluttered hallway

• an individual is positioned to be just within the patient’s hemianopia

• yoked prisms are added, until the individual is partially visible

• typical values
  * 2-6 pd at distance
  * 10 pd maximum at distance
  * 12-15 maximum at near for reading
“Scales – rod” procedure (D. Fong)

• combined gross dynamic posturography and egocentric localization
• stand with each foot on one scale, and check for equality of weights
• add yoked prisms until have equal weight
• see if that prism also centralizes the rod for egocentric localization
• if not the same, use the rod – based yoked prism estimation
VTE spatial localization board (C. Valenti; VTE; modified by Ciuffreda group)

• based on Werner et al. (1953) technique
• point with unseen hand at subjective straight ahead in an uncluttered room/wall
• place mark on calibrated paper below board
• add yoked prisms, until it becomes more central in location
• we have modified the board to be more stable and reliable
Conclusions

1. The egocentric localization (EL) aspect of the spatial sense is abnormal (i.e., AEL) in ABI, especially in CVA.

2. This produces a lateralward bias in the spatial frame of reference into the ‘seeing’ hemi-field.

3. The AEL can be assessed by a number of clinical techniques.

4. Yoked prism of both a “compensatory” and “therapeutic” nature can be of benefit to the patient.
Prism distortion: non-uniform magnification