Enhancing human navigation ability using an active wearable exoskeleton

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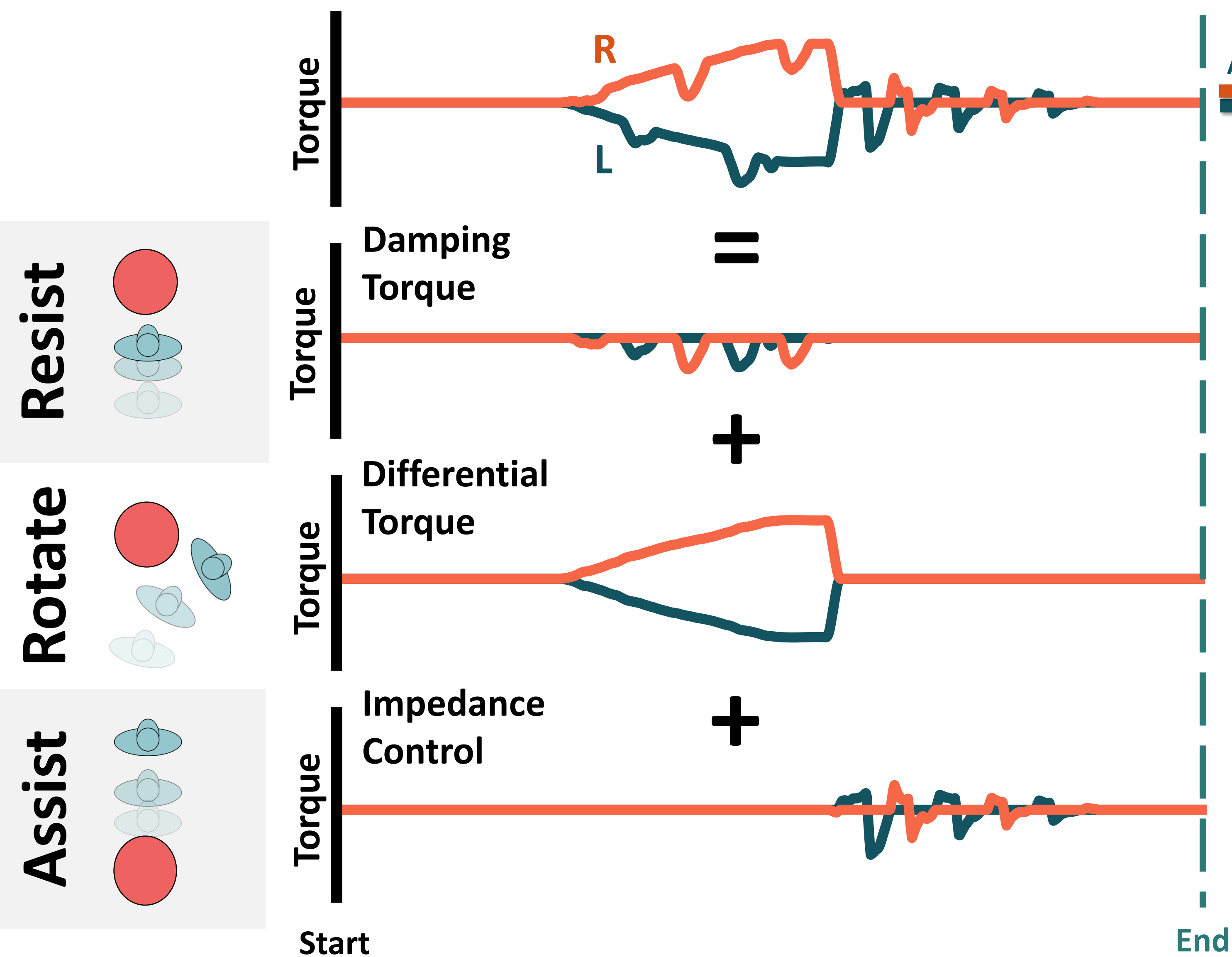
Scan for a video demo

Goal of This Project

How can we promote **safe navigation** when visibility is low?
- Visibility may be impaired by dust, smoke, dense fog, or poor eyesight.
- Existing tactile and auditory devices require single-purpose hardware.

Hypothesis: Tactile feedback from an active exoskeleton can improve navigation ability compared to vision alone.

How the Controller Works

Torque

R

L

=

Damping Torque

+

Differential Torque

+

Impedance Control

Start   End

Resist
Rotate
Assist

Acts on hip

1-DOF Hip Exo [1]

Repulsive Potential

Goal

Experiment

- N=10
- Performed in **virtual reality**
- 7 conditions, 16 levels/condition
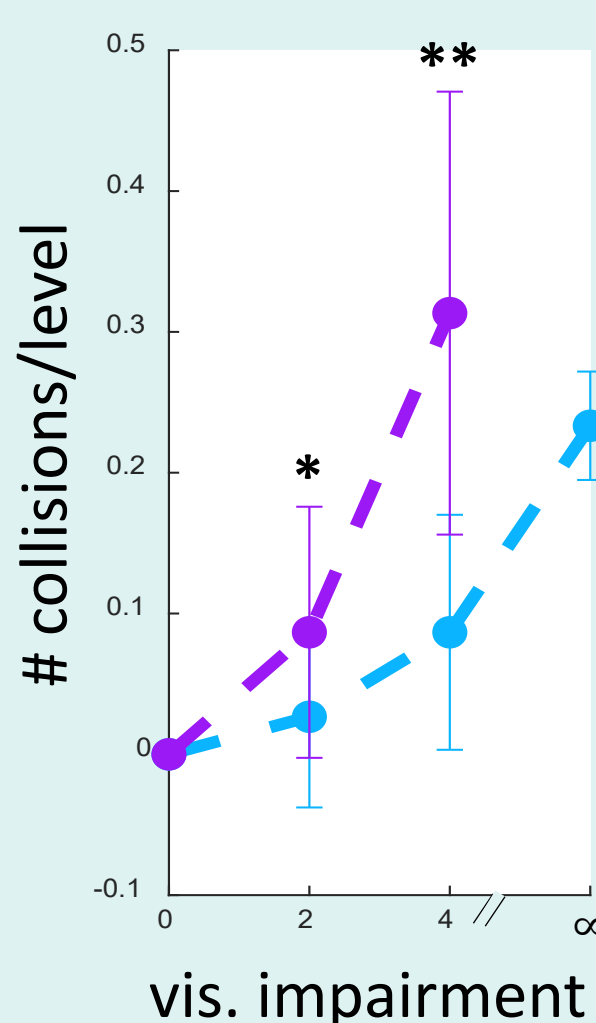- 3 obstacle danger levels, d

	Exo On	Exo Off
Clear		
⋮		
Blind		✗

Results

Collisions

Collisions were significantly reduced with exo in all visibilities except clear.

— exo on
— exo off
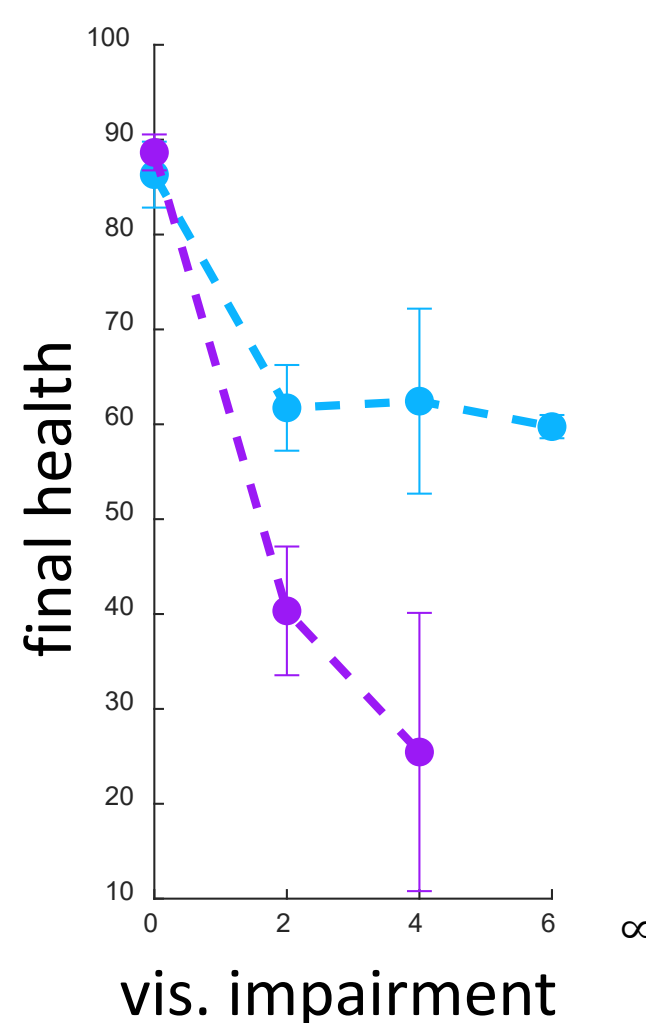
#collisions/level
*
**
vis. impairment

Health Metric

Performance with exo on was significantly better in all visibilities except clear.
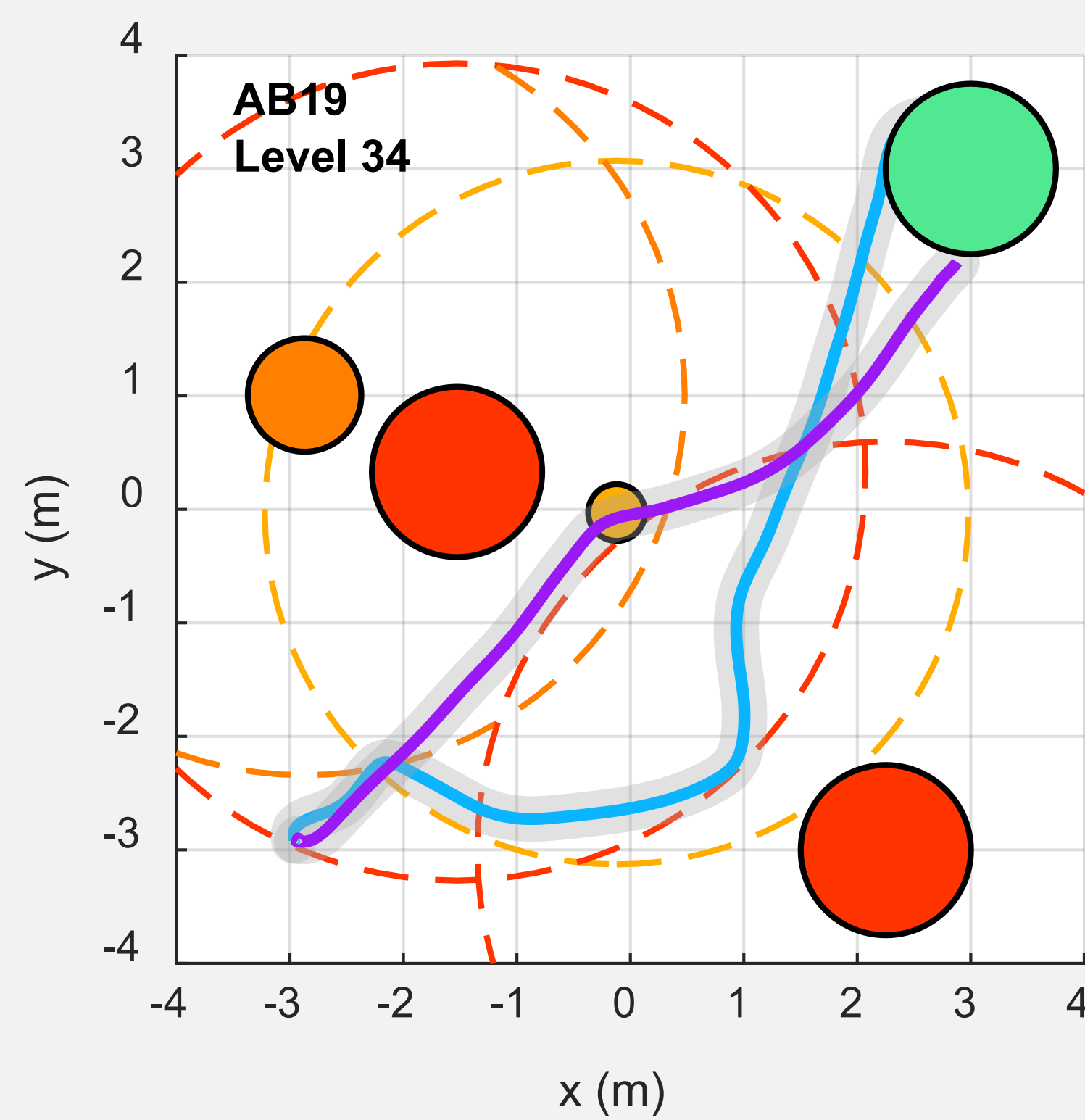
damage taken at t_i

$h_0 = 100$

$h_{i+1} = h_i - G \sum_{k=1}^{\#obstacles} d_k \frac{1}{r_k^2}$

G damage gain
d_k radius/danger level of obstacle k
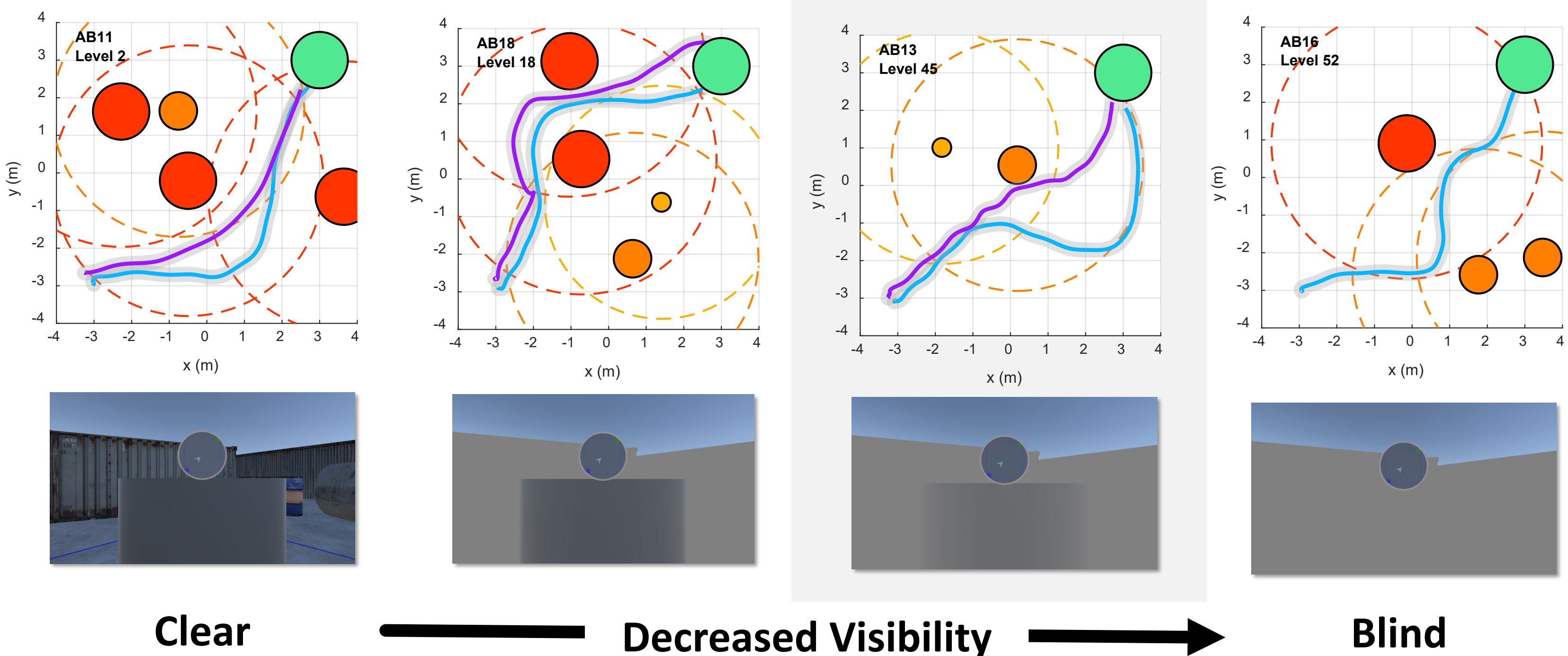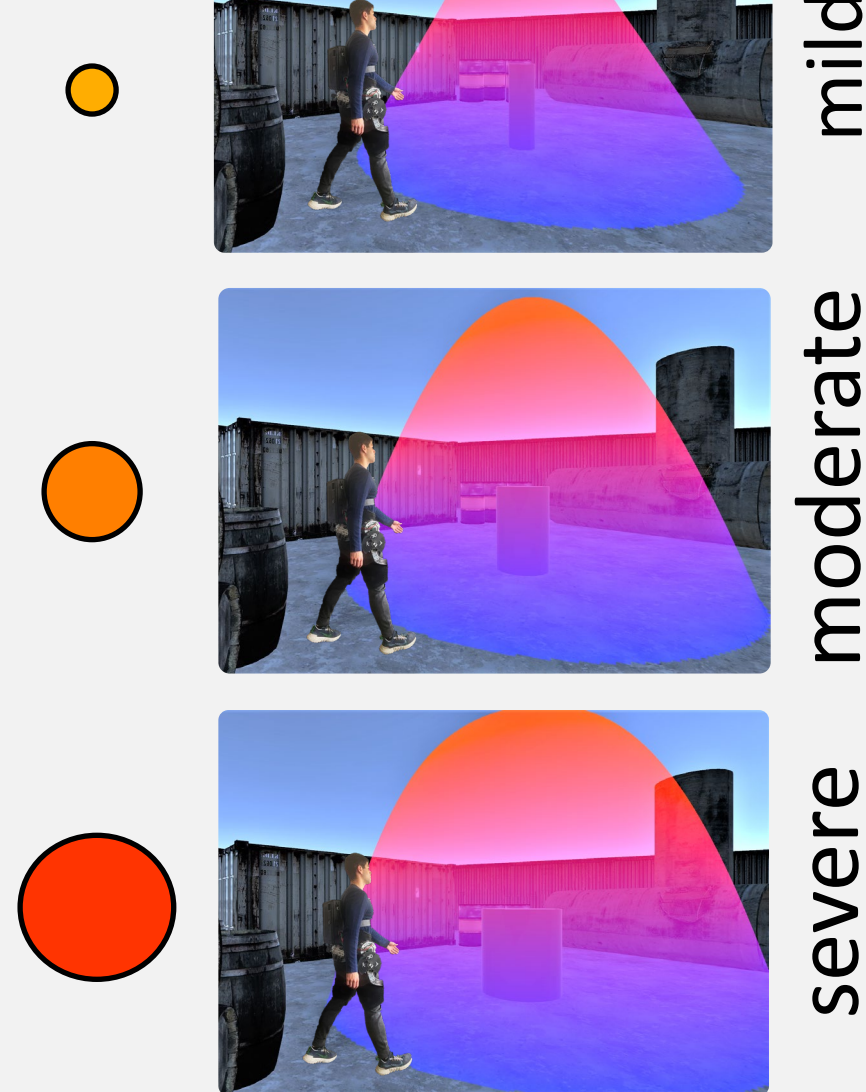r_k distance to obstacle k

final health
vis. impairment

Sample Trials

— exo on
— exo off

AB19
Level 34

y (m)
x (m)

Obstacle Danger Levels

mild
moderate
severe

AB11 Level 2
AB18 Level 18
AB13 Level 45
AB16 Level 52

y (m)
x (m)

Clear   **Decreased Visibility** →   **Blind**

ART   EPIC