Multiple Object Tracking: The Perception of Object Ensembles

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Background

- Humans can simultaneously track approximately 3-5 items (Pylyshyn & Storm, 1988).
  - This capacity limit is impacted by multiple factors, such as object speed (Alvarez & Franconeri, 2007), stimulus complexity (Horowitz et al., 2007), and individual differences (Oksama & Hyona, 2004).
- Our visual experiences extend beyond perceiving discrete objects (e.g., flock of birds, group of autonomous robots).
  - Gestalt principles of organization guide perception of objects into ensembles (Wagemans et al., 2012).

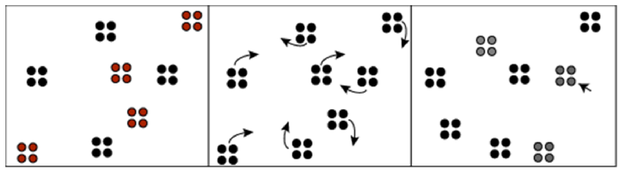
Primary Question

What properties of groups of objects affect tracking performance?

Methods

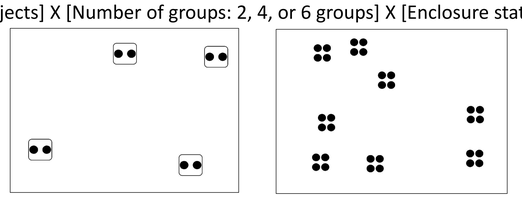
Multiple Object Tracking (MOT) Experiments: track groups of dots as they move among groups of distractors

Target groups highlighted (2s), 7s tracking phase, selection of target groups (Exp 1)/ dots (Exp's 2 & 3)

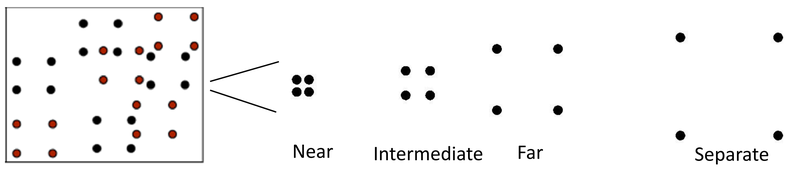


Experiment 1: Group Size Manipulation

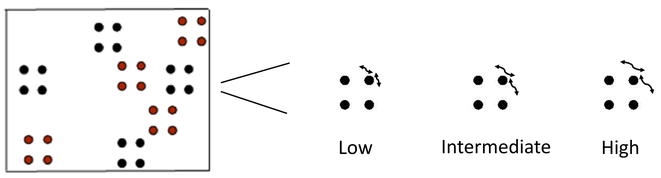
[2, 4, or 8 objects] X [Number of groups: 2, 4, or 6 groups] X [Enclosure status: yes or no]



Experiment 2: Inter-Object Spacing Manipulation



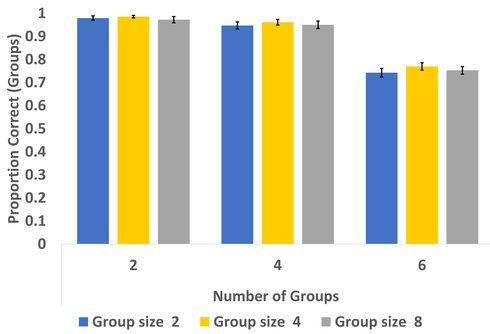
Experiment 3a & 3b: Movement Eccentricity Manipulation



Exp 3b: Expanded Eccentricities (~40% increase in movement eccentricity)

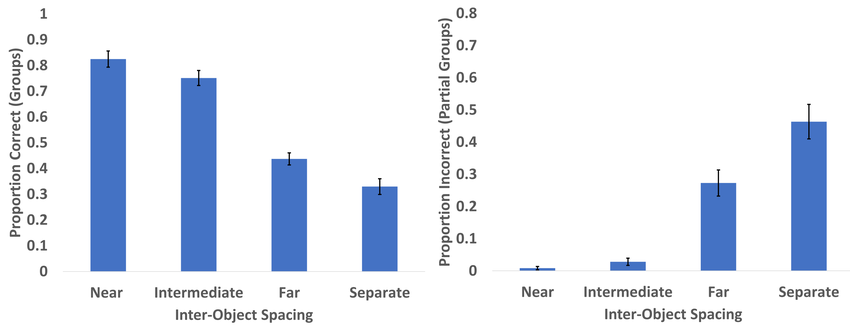
Results

Experiment 1: Group Size Tracking



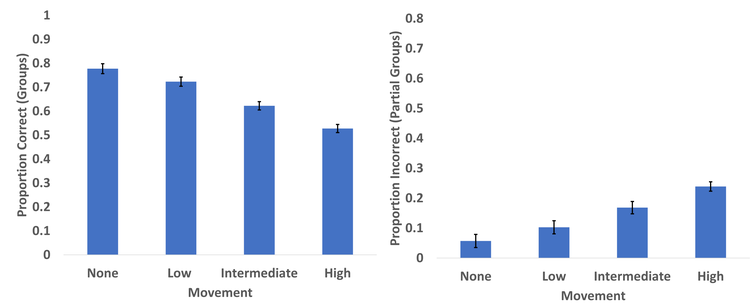
- Tracking performance high for 2 and 4 groups, declines for 6 groups.
- Performance similar across all group sizes and for enclosed and non-enclosed groups (non-enclosed depicted in figure above).

Experiment 2: Inter-Object Spacing Tracking



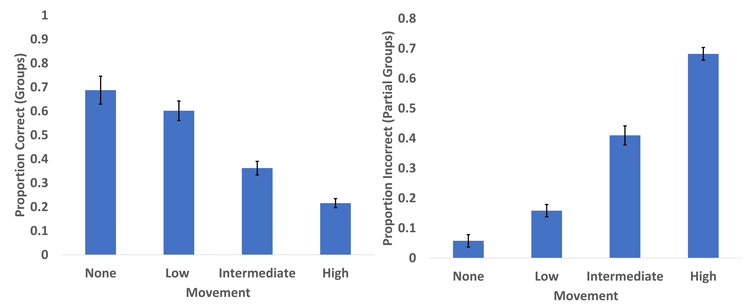
- As inter-object spacing increases, tracking performance gradually declines.
- Increased confusion between parts of groups for far and separate spacings compared to near and intermediate spacings.

Experiment 3a: Movement Eccentricity Tracking



- Tracking performance gradually declines as disruptions to common fate increase.
- Increased confusion between parts of groups as movement eccentricity expands.

Experiment 3b: Expanded Movement Eccentricity Tracking



- Increased confusion between parts of groups for intermediate and high movements compared to no and low movements.

Conclusions

- Tracking capacity estimates are approximately 4 groups of objects, regardless of the number of items a group is composed of. Group-based MOT operates similarly to object-based MOT.
- Group tracking performance declines as inter-object spacing increases and when common fate is disrupted. Within the context of MOT, perceptual groups are defined by proximity and common fate parameters.

References

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