Multiple Object Tracking through temporal gaps created by the fading of objects

Harry Haroutouni Haladjian1, 2, Zenon W. Pylyshyn1, & Allan Kugel1
1Rutgers Center for Cognitive Science, New Brunswick, NJ; 2Department of Psychology, Rutgers University, New Brunswick, NJ

1. Abstract
In three experiments, we examine whether the encoding of object location is used in Multiple Object Tracking. Observers were asked to track four target discs among eight identical distractors on a display where the same random-dot texture was used for object surfaces and display background. Stereoscopic glasses were used to create two display conditions: 3D (where objects appeared to float in front of the background texture) and 2D (where objects appeared on the display's background). Object locations were not always encoded and used to continue tracking after a gradual gap in visibility. This suggests that the tracking mechanism may not encode location information unless cued by abrupt changes in the visual scene.

2. Background
According to Visual Indexing theory, the success of Multiple Object Tracking (MOT) does not rely on the encoding and continual updating of object location or the extrapolation of motion trajectories (Pylyshyn, 1989, 2001).

3. Method
Participants: Rutgers students received course credit or remuneration for one 60-min session (only subjects who could see the stereo display participated).

Apparatus & Stimuli
Experiments were programmed in C with OpenGL (Linux OS) and presented on a 17” CRT color monitor with viewing angle of ~33.6° x 24.4°.

A random-dot grid of (random) grayscale values was used for the object and background texture in order to create two display conditions:
1) Stereo (3D) display: objects appeared to float in front of the background texture (using eDimensional shutter glasses and disparity), and
2) Mono (2D) display: objects appeared directly on the background texture (no disparity code).

Objects were circles with ~2.3 cm diameter (~2.1° viewing angle) and the same random-dot texture as the background. A white border 2 pixels thick was used for target flashing and the moving stimuli in Experiment 2.

Objects moved smoothly in straight lines until collision with the screen border or within ~2° of another object, and bounced in an “elastic” manner; objects never occulted one another.

4. Results
EXPERIMENT 1 (n=22)
Two display types: stereo (3D) & mono (2D). Four pause conditions: 0, 1, 2, & 4 seconds.

Results
ANOVA showed interaction between display and pause duration (F=4.6, p<.05), and main effects for display (F=3.0, p=.01) and pause durations (F=5.1, p<.01).
Stereo display showed significant difference between no pause and 1-s pause.
Mono display showed significant difference between the 4-s pause and all other pauses.

Tracking performance in trials with extended pause durations was further explored in Experiment 1b (for mono display only).

EXPERIMENT 2 (n=20)
Identical to Experiment 1, except objects had a constant white border throughout the trial.

Results
ANOVA showed an advantage for stereo (F=17.5, p<.001), with no interactions.

There was no effect of pause duration on tracking performance.

EXPERIMENT 3 (n=21)
Two display types (mono only): with flash or without flash (the object-borders flashed “on” for 15 ms immediately before pauses). Four pause conditions: 0, 1, 2, & 4 seconds.

Results
Overall ANOVA showed an effect only for pause duration (F=14.9, p<.001).

For the no-flash trials, significant differences between 4-s and all other pause conditions (replicating mono condition in Experiment 1).

For the flash trials, significant differences between: no-pause > 2-s, no-pause > 4-s, 1-s > 2-s, 1-s > 4-s, and 2-s > 4-s.

5. Conclusion
Objects that disappear gradually were more difficult to track during longer disappearances (4 or more seconds), indicating that object locations were not encoded effectively and used to continue tracking after a gradual gap in visibility.

This suggests that simply remembering locations does not benefit tracking – objects must remain visible for properties, such as location, to remain attached to the object.

Abrupt changes to tracked objects may reinforce location encoding, but further experiments testing this hypothesis are necessary.

6. References

Special thanks to Ryan McKendrick and Robyn White for assistance with data collection. For information about this and other projects at the Visual Attention Lab.

http://ruccs.rutgers.edu/finstlab/
haladjian@ruccs.rutgers.edu