JoVE: Science Education

Multiple Object Tracking

--Manuscript Draft--

Manuscript Number:	10019
Full Title:	Multiple Object Tracking
Article Type:	Manuscript
Section/Category:	Manuscript Submission
Corresponding Author:	Jonathan Flombaum UNITED STATES
Corresponding Author Secondary Information:	
Corresponding Author's Institution:	
Corresponding Author's Secondary Institution:	
First Author:	Jonathan Flombaum
First Author Secondary Information:	
Order of Authors:	Jonathan Flombaum
Order of Authors Secondary Information:	

PI: Jonathan Flombaum

Psychology Education Title
Multiple Object Tracking

Overview:

In a staggeringly complex and engaging world it is crucial to selectively process some stimuli at the expense of others. Experimental psychologists call this ability 'attention'. Visual attention, specifically, refers to the ability to selectively process aspects of a visual scene.

Many paradigms used to study visual attention involve brief, punctuated, and repeated trials (as do many paradigms in experimental psychology, broadly). However, everyday situations often place sustained demands on attention, as opposed to requiring only brief focus. For example, compare driving through busy city streets, which demands sustained attention, with crossing a busy street, which demands just a few moments of caution. To investigate sustained visual attention, experimental psychologists often rely on a paradigm called 'multiple object tracking.'

This video demonstrates standard procedures for investigating sustained visual attention through multiple object tracking.

Procedure

1. Stimulus design (Figure 1)

1.1. The basic design of a multiple object tracking (MOT) trial is relatively straightforward. A trial begins with some number of identical objects in a display, such as blue discs. Typical trials include eight discs in total, but varying the number is a crucial manipulation.

1.2. A randomly selected half of the discs turns yellow. Turning yellow indicates to the participant which discs are the targets.

1.3. After they turn yellow, all the discs become identically colored again, and all, including the nontargets, move about the display randomly, usually for about ten seconds.

1.4. The participant's task is to mentally track the target discs.

1.5. After the motion period is complete, all the discs stop moving, and the participant uses the mouse to click once on each disc they believe is a target.

2. Procedure

Comment [DM1]: Aaron, I know you mentioned (in the Lester manuscript feedback) having figure call-outs embedded in the actual text, but I wasn't sure how to do that for this. Figure 1 is essentially a graphic recap of steps 1.1.-1.5. Therefore I thought it was best called-out at the start of this section.

2.1. The above procedure is repeated using several different tracking loads (number of targets a person is asked to track), for example, 2, 3, 4, 5, 6 and 7 (and equal numbers of nontargets).

2.2. 10 trials with each load are conducted in total.

3. Analysis

3.1 Compute the number of targets correctly identified in each trial —i.e. the number of items selected as targets that were actually targets. On each trial, the result is an accuracy score between 0 and 100%. Averaging these scores together for all trials with the same tracking load gives the experimenter a sense of the number of targets the individual can track.

Representative Result

The results of the experiment include several subjects, and that average performance for the group of participants is reported as a function of tracking load. Graphing those data looks like this (**Figure 2)**:

Applications

For the last 25 years, multiple object tracking has been one of the primary methods for investigating the limits of human sustained attention, and the causes of those limits. It can be used to investigate differences in attentional abilities between individuals in different populations, such as those with ADHD compared to age-matched controls. And it can be used to investigate the efficacy of interventions for improving sustained attention, for instance, the effects of drugs such as Ritalin or Adderall.

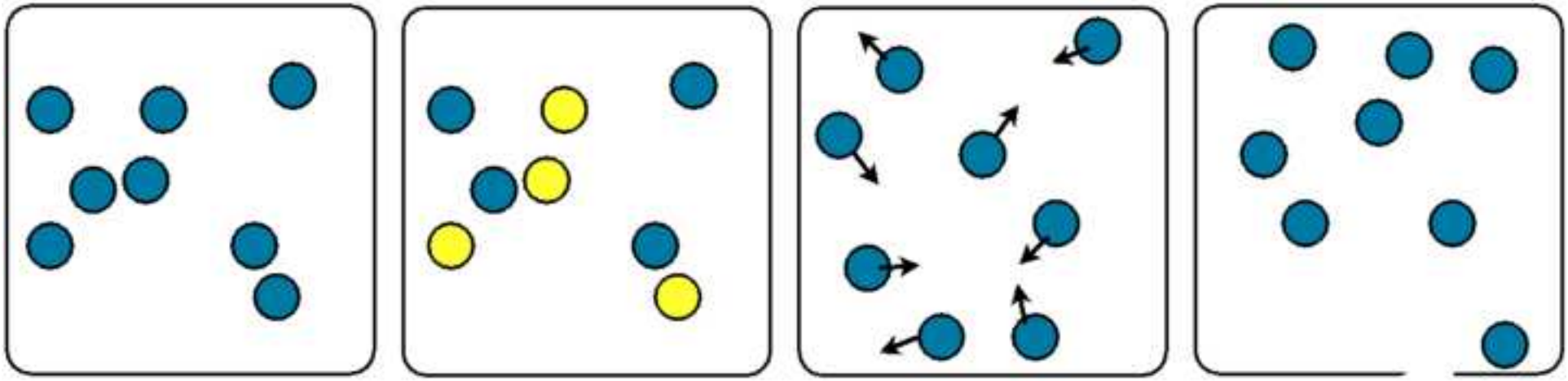
One area in which the paradigm has been used especially productively and influentially is investigating the human ability to multitask. When a person is driving a car down the highway —a task that clearly requires sustained attention— what will the impact be of talking on a cell phone, for example? Asking people to do this for the purpose of an experiment is ethically questionable. Instead, researchers have used multiple object tracking to investigate the impacts of engaging secondary tasks on the performance of sustained attention, including the secondary task of talking on a cell phone. The result, perhaps unsurprisingly, is that participants make significantly more tracking errors when asked to engage in a conversation over the phone with an experimenter in another room.

Legend:
Figure 1 – Schematic depiction of a typical multiple object tracking trial. A participant tracks a subset of discs that moves randomly among a group of identical nontargets.

Figure 2 – A depiction of typical tracking performance as a function of target load. Researchers often find that participants perform relatively accurately with only two to four targets to track, then suffering large costs when asked to track more than four or five.

Photo or Graphic File
Click here to download high resolution image

Schematic Depiction of a Typical Multiple Object Tracking Trial



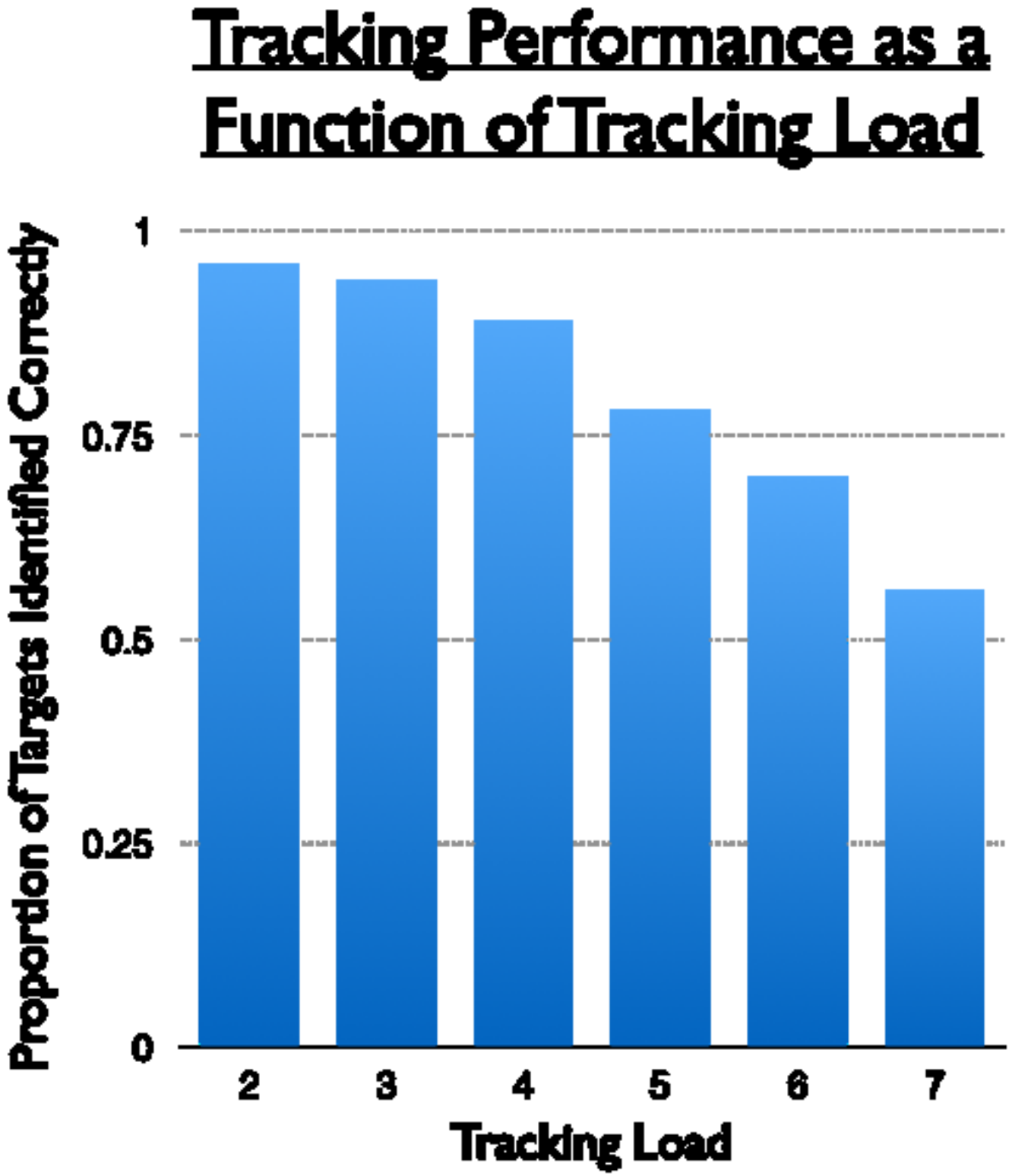
1. Identical discs randomly distributed through display

2. Half of the discs identified as targets (shown in yellow)

3. Discs all move randomly for 10 seconds — the tracking period

4. Participant selects (with the mouse) the discs he or she believes are the targets

Photo or Graphic File
Click here to download high resolution image



PI: Jonathan Flombaum
Psychology Education Title: Multiple Object Tracking

Overview

In a staggeringly complex and engaging world, it is crucial to selectively process some stimuli at the expense of others. Experimental psychologists call this ability, "attention." Specifically, visual attention refers to the ability to selectively process aspects of a visual scene.

Many paradigms used to study visual attention involve brief, punctuated, and repeated trials (as do many paradigms in experimental psychology, broadly). However, everyday situations often place sustained demands on attention, as opposed to requiring only brief focus. For example, compare driving through busy city streets, which demands sustained attention, with crossing a busy street, which demands just a few moments of caution. To investigate sustained visual attention, experimental psychologists typically rely on a paradigm called multiple object tracking.

This video demonstrates standard procedures for investigating sustained visual attention through multiple object tracking.

Procedure

1. Stimulus design (**Figure 1**).

    1.1. The basic design of a multiple object tracking (MOT) trial is relatively straightforward: begin the trial with a number of identical objects (such as blue discs) in a display. For the typical trial, include 8 discs in total, but varying the number is a crucial manipulation.

    1.2. Randomly select half of the discs to turn yellow. Turning yellow indicates to the participant which discs are the targets.

    1.3. After they turn yellow, have all the discs become an identical blue color again, and move all, including the non-targets, around the display randomly for about 10 sec.

    1.4. Instruct the participant to mentally track the target discs.

    1.5. After the motion period is complete, stop all the discs from moving, and tell the participant to use the mouse to click once on each disc they believe is a target.

2. Procedure.

    2.1. ~~The above procedure is repeated using several different tracking loads (number of~~

Comment [DM1]: Aaron, I know you mentioned (in the Lester manuscript feedback) having figure call-outs embedded in the actual text, but I wasn't sure how to do that for this. Figure 1 is essentially a graphic recap of steps 1.1.-1.5. Therefore I thought it was best called-out at the start of this section.

Comment [AK2]: This is OK.

~~targets a person is asked to track), for example, 2, 3, 4, 5, 6 and 7 (and equal numbers of nontargets).~~In order to determine how many objects people can track~~,~~ on average, use the basic design ~~just~~ described in Step 1 and~~can be~~ translate it~~d~~ into a procedure for a whole experiment.

2.2. For this demonstration, find ~~Suppose a researcher wants to know~~ how many objects a group of college-aged males can track.

2.3. ~~The researcher will r~~Recruit at least 10 participants within the age~~at~~ group (ages 18-22) to participate in the study.

2.3.1. For students in this age group, researchers on college campuses usually have mechanisms in place by which students can be recruited from Psychology courses.

2.4. When the ~~each~~ participant~~s~~ arrive~~s at the lab~~, ~~they~~~~he will be~~ ask them~~ed~~ to consent in writing to participate in the experiment.

2.5. ~~Then, the experimenter will a~~Ask the participants if ~~he has~~they have any known eyesight impairments~~,~~ or ~~otherwise,~~ if eyesight is close to 20-20 once any necessary glasses or contacts are worn. If the participants have~~s~~ close to 20-20 vision, either with or without correction, ~~he is~~they are qualified to run in the experiment.

2.6. Seat~~Next,~~ a~~the~~ participant~~s are is seated~~ in front of a computer that ~~will~~ runs the experimental program. Ensure that the participant sits approximately 60 cm away from the monitor (~~A~~a piece of tape ~~or some other marking~~ on the floor in front of the computer marks~~will tell the experimenter where to~~ the position of the leading edge of the participant~~'s~~'s seat).~~s to ensure that participants sits approximately 60 cm away from the monitor.~~

~~2.1.~~ ~~The researcher will e~~Explain the instructions to the participant, emphasizing that some trials may seem difficult, but ~~that~~ they ~~participants~~ should always do their ~~his~~ best, and ~~that they he should guess~~ if they ~~he~~ find~~s~~ themselves ~~himself~~ uncertain about the identity of some targets in some of the trials, then they should just guess.

~~2.2.~~2.7.

2.8. Have the participant~~The participants will then~~ complete 5 practice trials with only 2 targets in each. ~~The researcher will r~~Remain in the room, using the practice trials to ensure that the participant~~s~~ has~~ve~~s understood the instructions.

2.9. Leave~~ft alone in~~ the testing room and have~~,~~ the participant~~s~~ complete~~s~~ 60 trials in a random order~~,~~ with 10 trials each including 2, 3, 4, 5, 6, and 7 targets (and equal numbers of non-targets).
~~10 trials with each load are conducted in total.~~

Comment [AK3]: The above is an explanation of an experimental design, not what we would consider a procedure. The organization of the submission is totally adequate, but the procedure section should deal more with the experimenter subject interactions, getting consent, setting up the experiment, etc. How is the subject positioned? Does one control for distance from the computer screen? Does the experimenter control for differences in eyesight amongst participants? Is there a participant selection process?.

3. Analysis.

3.1. Compute the number of targets correctly identified in each trial (i.e. the number of items selected as targets that were actually targets).

~~3.2.~~ On each trial, the result is an accuracy score between 0 and 100%. Average these scores together for all trials with the same tracking load. This gives the experimenter a sense of the number of targets the individual can track.

~~3.3.~~3.2.

Representative Result

The results of the experiment include several subjects, and the average performance for the group of participants is reported as a function of tracking load. The data can be graphed for visualized results (**Figure 2**).

Applications

For the last 25 years, multiple object tracking has been one of the primary methods for investigating the limits of human sustained attention and the causes of those limits. It can be used to investigate differences in attentional abilities between individuals in different populations, such as those with ADHD compared to age-matched controls. And it can also be used to investigate the efficacy of interventions for improving sustained attention, for instance, the effects of drugs, such as Ritalin or Adderall.

The paradigm has been used productively and influentially in investigating the human ability to multitask. When a person is driving a car down the highway — a task that clearly requires sustained attention — what will the impact be of talking on a cell phone, for example? Asking people to do this for the purpose of an experiment is ethically questionable. Instead, researchers have used multiple object tracking to investigate the impacts of engaging secondary tasks on the performance of sustained attention, including the secondary task of talking on a cell phone. The result, perhaps unsurprisingly, is that participants make significantly more tracking errors when asked to engage in a conversation over the phone with an experimenter in another room.

Legend

Figure 1: Schematic depiction of a typical multiple object tracking trial. A participant tracks a subset of discs that move randomly among a group of identical nontargets.

Figure 2: A depiction of typical tracking performance as a function of target load. Researchers often find that participants perform relatively accurately with only 2-4 targets to track, then suffer large costs when asked to track more than 4 or 5.

Comment [JR4]: Potential photos:

Effect of ADHD drugs:
http://www.shutterstock.com/pic-170808884/stock-photo-attention-deficit-hyperactivity-disorder-or-adhd-medical-or-healthcare-background.html?src=dRrqT8KdO_xWAmgUi0dAQQ-1-7

Talking while driving:
http://www.istockphoto.com/photo/young-man-speaking-on-telephone-and-driving-car-17351980?st=f251f2f

http://www.istockphoto.com/photo/careless-woman-at-traffic-30256472?st=f251f2f