The Oddity Detection in Diverse Scenes (ODDS) database: Rated and validated real-world scenes for studying anomaly detection

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Introduction

- Medical image perception is a challenging (but societally important) search task for which standard laboratory paradigms are often a poor analogue.

Laboratory search	Medical image perception
Targets are precisely defined, unambiguous, often nameable.	Targets are potentially ambiguous oddities; anomalous tissue that doesn't belong.
Objects are presented in isolation on blank backgrounds.	Anatomical structures adjoin and overlap; anomalies are embedded within the tissue.
No meaningful spatial structure and arrays are randomized to prevent influence of memory.	Meaningful spatial structures and patient case history provide clues on where/how to look for targets.

Representative pre-search and search displays (left and middle) from Hout et al. (2015). Medical image perception from Shiraishi et al. (2000; right).

The ODDS Database

- This database mimics key characteristics of medical image perception but has reduced stimulus complexity so that less experienced searchers (e.g., college students, untrained volunteers) can perform reasonably well.
- Database consists of 284 unedited images obtained from Unsplash.com (an online repository of freely usable, high resolution images). Scenes categories are forests (144), indoor scenes (96), or libraries/books (44).
- Images are high-resolution, landscape format, and are comprised of mostly meaningful information (i.e., no large sections of open sky or blank walls).

Image Manipulation

- Original images were manipulated to contain an "oddity" target; i.e., a ripple/deformation of the scene that can be used as the target of search. (See Hess et al., 2016.)
- Each scene was manipulated multiple independent times to create 16 "variants" of the original, each with a target in a different spatial location (for a total of 4,576 edited images). Unedited images can be used for "target-absent" trials.
- To standardize size and possible target locations, 16 "cells" were determined within a central 1920x1080 "box" and targets were randomly jittered within cells.

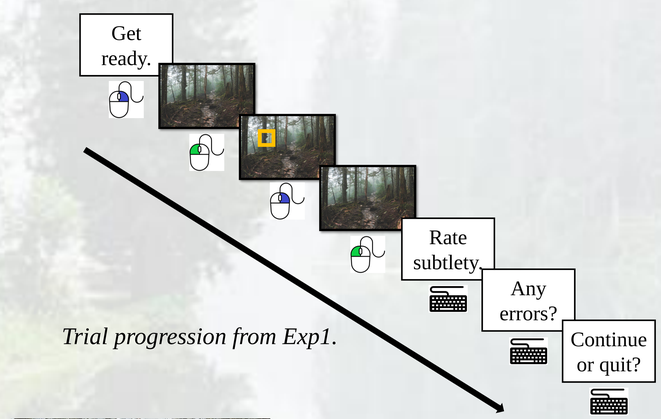
Demo of image manipulation with central "box" shown in dotted lines and randomly jittered target locations within each "cell."

Exp 1: Target Subtlety Ratings and Initial Validation

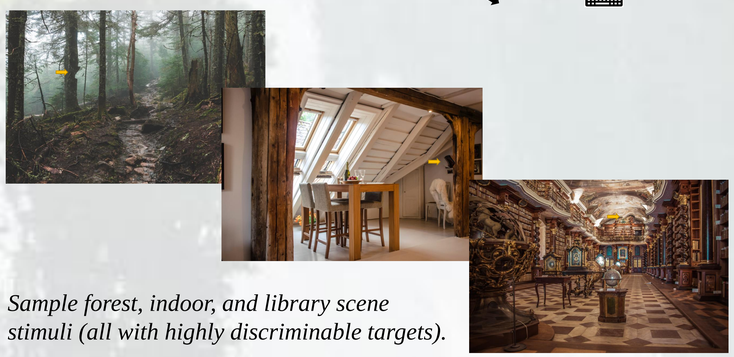
- Target locations were quasi-randomly determined and thus they vary in their subtlety depending on the local scene content and features present at that location.
- For instance, target oddities that appeared in dense clusters of forest leaves or on homogenous surfaces indoors did not "disturb" the background content and so are very subtle. By contrast, targets that occur near edges (e.g., a tree trunk, a picture frame) are less subtle because they break continuity.
- The purpose of Exp1 was to provide subjective ratings of each target/variant and to validate them by using them to predict search performance.

Exp1 Method & Results

- Eight independent raters assessed subtlety of each variant in each scene (in random order). The same observers (*prior* to giving ratings) performed search for the oddity targets.
- Participants were given 5 seconds to search through each scene and click on the target; then, it was highlighted with a yellow border to direct attention (in case it was missed).
- The highlight was then removed to show the target in its bare context, after which the participant rated the subtlety of the target on a 1 (extremely subtle) to 5 (obvious) scale.

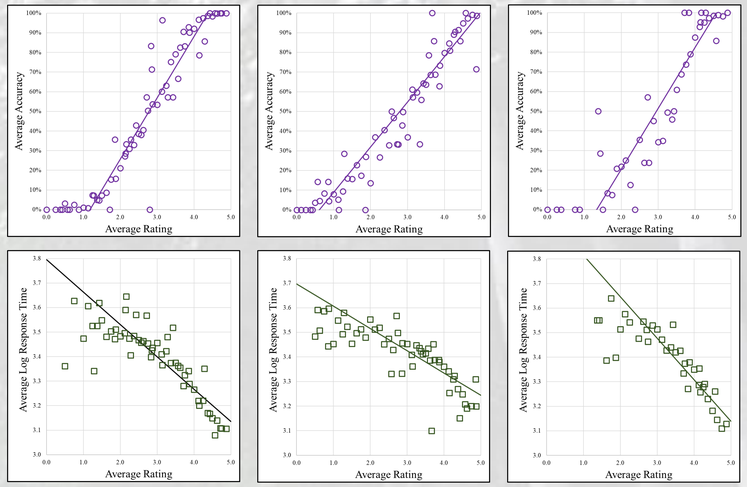


Trial progression from Exp1.



Sample forest, indoor, and library scene stimuli (all with highly discriminable targets).

Forests | Interiors | Libraries/Books

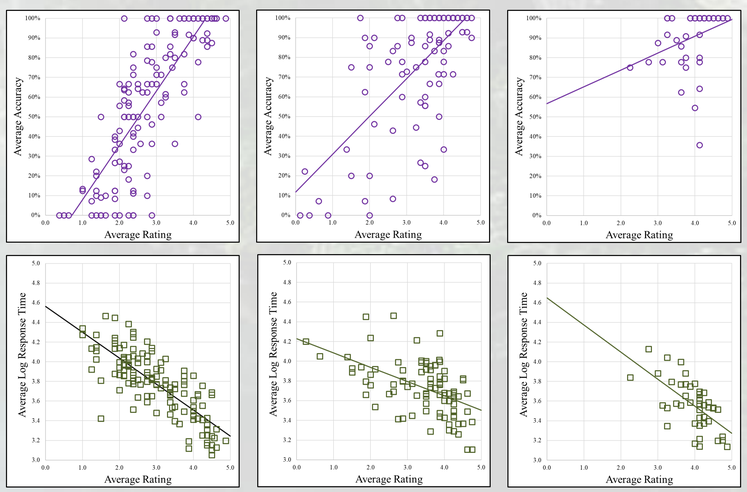


Plots of linear regression analyses using average subtlety scores to predict search outcomes. Top panels show accuracy data, bottom panels show log RTs. Individual symbols are mean performance for a given mean rating value and solid lines plot best fitting regression equations (all ps < .001).

Exp 2: Validation with naïve participants

- The main possible shortcoming of Exp1 are that: 1) practice effects may have arose over time; 2) task volume may have resulted in fatigue; 3) search trials were very short; and 4) participant co-authors were not naïve to the purpose of the study.
- In Exp2, a naïve group of 46 participants searched for up to 30 seconds through a small subset of the scenes, never encountering a scene more than once.

Forests | Interiors | Libraries/Books



Plots of linear regression using average rating scores obtained in Exp 1 to predict search outcomes from Exp 2. Individual symbols show performance for every scene variant presented.(all ps < .05).