

How Target/Distractor Discriminability Affects Search Guidance Strategy

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ABSTRACT

A search template that guides attention toward visual targets can be adjusted according to experience. The present study manipulated the discriminability between target and distractor colors to determine whether difficult (low) discriminability elicits more precise representation of the target colors than easy (high) discriminability. It also explored whether participants shift away from color guidance when forced to make more difficult discriminations. One group searched through randomly mixed trials with easy- or difficult- discriminability arrays of colored T targets among colored Ls, and another group searched through easy- discriminability displays only. We compared fixation data from the easy-discriminability trials in both groups: participants with experience of difficult discriminability had more unguided fixations to distractors with very different colors from the target, suggesting that participants use color information less to guide search when color discriminability might be difficult. There was no evidence that difficult discriminability prompted participants to encode target colors more precisely.

BACKGROUND

A search template that guides attention toward visual targets can be adjusted according to experience.

- Bays and Husain (2008) show that precision of memory representations can vary across conditions.
- The search template can be adjusted to match different target features within a dimension (Navalpakkam & Itti, 2006).
- Observers can make different search templates for the same target in different contexts (Bravo & Farid, 2016).

RESEARCH QUESTION

Does the experience of difficult color discriminability elicit more precise representation of the target colors than easy discriminability?

Or does it make participants less likely to use color to guide search?

STUDY DESIGN

Visual search task

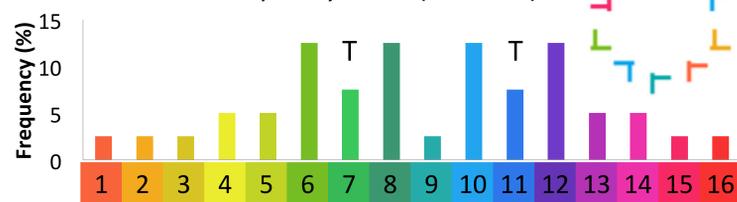
Search for a T among Ls; T is one of two colors. Respond whether a target is present (Stroud et al., 2012).

Color guidance can make search more efficient, but is not required to find the target.

Two type of trials

- **16-color trials:** 16 colors were used for target and distractor colors. Also, distractors frequently appeared with target-similar colors.

Frequency table (16-color)



- **8-color trials:** 8 colors were used for target and distractor colors. All colors were equally likely to appear.

Two discrimination groups

Hard discrimination group: in half of the trials, participants experienced very difficult search.

- 50% 16-color trials (Hard16) + 50% 8-color trials (Hard08)

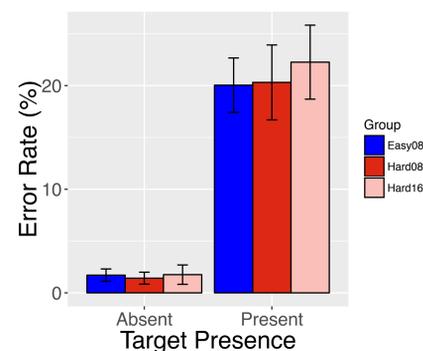
Easy discrimination group: participants did not experience difficult search.

- 100% 8-color trials (Easy08)

RESULTS

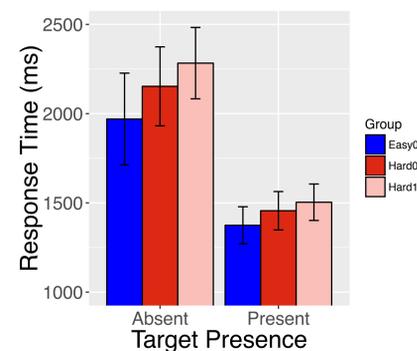
Did participants who experienced difficult color discriminability use color information more effectively than participants who did not? (only 8-color trials were used for statistical analysis; Easy08 vs. Hard08)

ERROR RATE



- No main effect of group, $p = .991$.
- Main effect of target presence, $p < .001$.***
- No sig. interaction, $p = .79$.

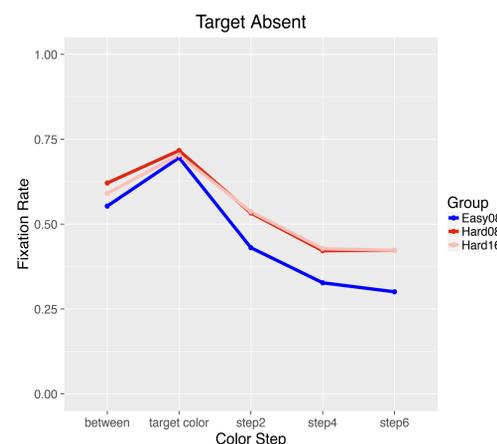
RESPONSE TIME



- No main effect of group, $p = .257$.
- Main effect of target presence, $p < .001$.***
- No sig. interaction, $p = .368$.

FIXATION RATE

$$\text{Fixation rate} = \frac{\# \text{ of items fixated}}{\# \text{ of items presented}}$$

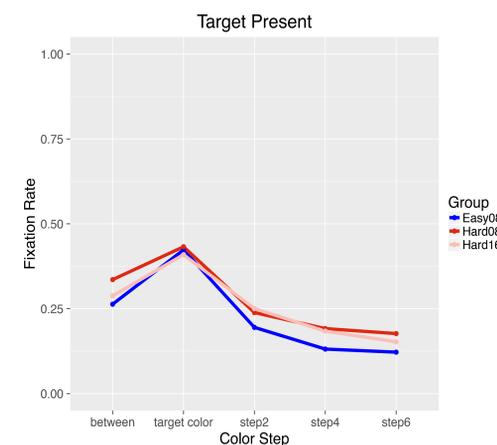


Mixed-factor ANOVA (color-step X group)

- Main effect of group, $p = .028$.*
- Main effect of color-step, $p < .001$.***
- Significant interaction, $p = .007$.**

Model separates effects of fixations unguided by color and selectivity (ability to avoid target-similar colors) (Menneer et al., 2015; 2016)

- Unguided fixation rate was higher in Hard08 than Easy08, $p = .039$.*
- Selectivity was not significantly different between two groups, $p = .088$.



Mixed-factor ANOVA (color-step X group)

- Main effect of group, $p = .023$.*
- Main effect of color-step, $p < .001$.***
- Marginally significant Interaction, $p = .065$.

Model parameters

- Unguided fixation rate was not significantly different between two groups, $p = .164$.
- Selectivity was not significantly different between two groups, $p = .369$.

* $p < .05$, ** $p < .01$, *** $p < .001$

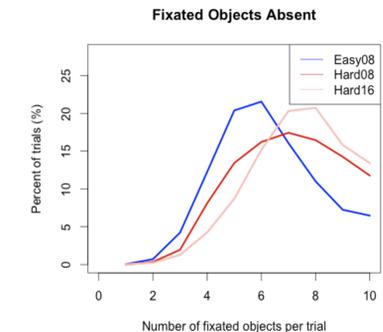
The **Hard** group was not more selective in fixating colors than the **Easy** group. Instead, the **Hard** group fixated more distractors, including those that were very different from target colors.

Participants use color information less to guide search when color discrimination is difficult.

RESULTS

How did participants who experienced difficult color discriminability guide search? (only 8-color trials were used for statistical analysis; Easy08 vs. Hard08)

THE NUMBER OF FIXATED OBJECTS

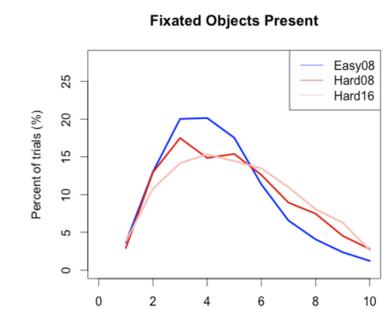


Mean number of fixated objects

- Easy08: 6.26

- Hard08: 7.03

$t(61.8) = 2.44, p = .017$.*



Mean number of fixated objects

- Easy08: 4.38

- Hard08: 4.84

$t(61.2) = 2.29, p = .025$.*

(The number of items in a search array is 10)

The **Hard** group fixated more objects per trial than the **Easy** group did.

Color guidance is less effective for the Hard group, so they fixate more objects.

SUMMARY & CONCLUSION

We compared search performance between two different groups with and without the experience of hard color discriminability. The Hard group fixated more target-dissimilar distractors than the Easy group did, even in the search arrays that were identical for both groups. Also, the Hard group fixated more objects per trial than the Easy group.

In conclusion, the participants used color less effectively to guide search when target colors were difficult to distinguish from distractors on some trials.

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Lab website <http://blogs.umass.edu/vcalab/research>

