Interference Model for Change Detection Task

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Abstract

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Keywords: [Click here to add keywords.]

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# Experiment A and B

The goal of Experiment A and B was to acquire the data for model comparison by using single-probe change-detection task. Because the Inference rule assumed a particular probe scheme, we tested two different probe schemes in the Experiment A and B. The probe selection scheme in Experiment A followed the assumption of the Inference rule, i.e., the probe color for *no change* condition was identical to the target color, and the probe color for the *change* condition was randomly choose from any color that is not the target color with equal probability. The probe scheme of Experiment B followed the traditional probe scheme for single-probe change-detection task. The probes from the *no change* condition are sampled around the target color, and the probes from the *change* condition are either sampled from the non-target colors or from the colors what are not around target and non-target colors.

## Method

### Participants

Experiment A and Experiment B both included twenty participants recruited from University of Zurich. Participants had normal or corrected-to-normal vision and no colorblind. Participants were rewarded with course credits or 60 Swiss Francs after completing the Experiment A and 45 Swiss Francs after completing Experiment B.

### Material

Color patches selected from a color wheel which was created in CIE L\*a\*b\* color space with a radius of 60 and centered at luminance set to 70, *a* set to 20, and *b* set to 38. The minimum distance between selected colors is 1 degree. The stimuli were displayed in RGB value with Gamma correction for IEC 61966-2-1 standard.

### Procedure

Experiment A consisted of four identical sessions, and Experiment B consisted of three identical sessions. All the sessions were conducted at different days, and each session took about one hour to complete. Experiment A consists of xxx trials, and Experiment B consists of xxx trials. The procedure in the trials are identical for both Experiment A and B.

At the beginning of each trial, several color patches were displayed on the screen for 500ms, which was followed by a blank screen for 500ms. The number of color patches ranged from one to six. The locations of the color patches were randomly selected from 13 possible locations on an invisible circle which centered at the center of screen. After the blank screen, a probe was displayed on one of the stimuli locations, and empty frames were displayed on the rest of the stimuli locations. Participants were asked to judge if the probe is the same color as the color patches presented previously at the same location by pressing left mouse button for “same” or right mouse button for “change”. After participants made their response, a blank screen appeared for 500ms and was followed by the beginning of the next trial.

In Experiment A, the probe matched the target color in 50% of the trials. For the remaining 50% of the trial, the probe was selected randomly from any possible colors other than target color. In Experiment B, the probe color was selected within a boundary around the target color 50% of the trials. In 25% of the trials, the probe color was selected within a boundary around the non-target color. For the remainder of the trials, the probe color was selected from the colors not within the boundaries of the target color and non-target colors. The only exception was in set size 1, since there was no non-target item, the probe was either selected within the boundary around the target color in 50% of the trials or any other possible colors for the remainder 50% of the trial. The boundary for selecting the probe color around target and non-target colors varies according to the set size of the trial, which was b1, b2, b3, b4, b5, and b6 for set size one to six, respectively. The boundary was based on the response deviance observed from the continuous-reproduction task for other study (cite). The probe scheme for Experiment A and Experiment B are illustrated in Figure 1.

## Model Comparison

We fitted the Interference Model, Slot-averaging Model, and Variable Precision Model to the data with the Baysian Inference rule. The models were implemented in Python 3.6, and the parameters were estimated with evolution assimulating algorithm in SciPy (CITE). The goodness-of-fit of the model was calculated via -log-likelihood. To avoid local minimum, the fitting process was repeated 10 times with different starting values (automatically chosen by the evolution assimulating algorithm), and the best fitting result was reported. To balance the different number of parameters in the models, we used AIC and BIC to compare between models.

However, there are some rooms of interpretation in the basian inference rule (cite donkin 2016). In the IM, we were unsure what level of knowledge was involved in the Bayesian inference rule on two dimensions. The first dimension is whether the Bayesian Inference rule has the knowledge of the target is in the focus of attention or know. If the target is in the focus of attention, the target would have higher precision and resistance to non-target interference. Having the knowledge of the target item is in the focus of attention or not would affect the precision of recall and the probability of recalling the target in the decision rule. The second dimension is whether the Bayesian Inference rule has the knowledge of the probability of recalling the target in the current trial or simply the mean probability of recalling the target at the current set size. While it is possible that participants were able to correctly evaluate the probability of recalling the target from trial to trial, it is also likely possible that participants only had a grasp of the average probability but not down to trial by trial variance. We tested four versions Bayesian inference rule generated by the cross product of the two dimensions. The one involved the knowledge of whether the current target is in the focus of attention or not and only has the grasp of the average probability of recalling the target across different set sizes, and the following report was based on said version.

For the Slot-Averaging model, we tested two Baysian inference rule with different level of knowledge. The first inference rule had the knowledge of the current target is in the memory or not. If the target is in the memory, the recalled color always come from the target color, i.e., P\_s=1. If the target is not in the memory, however, the inference rule can only guess with 0.5 probability of change response. The second inference rule assumed that the knowledge of whether the target is in the memory or not is not accessible for the inference rule, but only the general probability of recalling the target is available. The fitting result shown that the second inference rule performed way better than the first one, as shown in Figure x. Therefore, for the following comparison, we used the inference rule which doesn’t have the knowledge of whether the target item is remembered or not.

The model fittings are shown in Figure x. Overall, all the models were able to fit the similarity gradient effect and the set-size effect for the same probes. However, only the IM was able to predict the worse performance of the internal change probes comparing to the external change probe. The goodness-of-fit shown that IM is the best fitting model out of the three. On average, the IM won on the SA and the VP over xx and xx on AIC and xx and xx on BIC per participants, see Table x for the summary of the goodness of fits. The SA and the VP fitted the data poorly mostly due to failed to fit the worse performance of the internal change probes comparing to the performance of the external change probes, and the fitting algorithm had to compromise between the performance of the internal change probes and external change probes.

The failure of predicting the worse performance of the internal change probe is due to the lack of ability to recall around the non-target location. For both the SA and the VP, the non-targets were ignored while recalling the target. Hence, the internal change probes were treated in the same way as external change probes, which results in the same prediction for both internal and external change probes. The IM, however, assumed that non-targets caused interference for recalling the target (from both activation A and activation C). Some recall responses were centered around the non-target colors, which caused the worse performance of the internal change probes comparing to the external change probes.

To compensate the lack of ability to predict the non-target responses, we also fitted the variants of the SA and the VP which were able to predict the non-target response, namely: SA-Swap and VP-Binding. The SA-Swap assumes that the swap error occurs between remembered items, and the probability of making the swap error increases linearly with set sizes. VP-Binding assumed that the color-location binding information also remembered during the encoding and recognition process, and the location is used to retrieve the bound color. Please refer to Oberauer & Lin 2017 for more detail about the SA-Swap and VP-binding model.

Both SA-Swap and VP-binding were able to capture the general trend in the data, including the worse performance of the internal change probes. However, both AIC and BIC indicated that SA-Swap and VP-binding are inferior in compare to IM, as shown in Figure x.

## Conclusion and General Discussion

Generic conclusion

In this study, we tested the

Swap error in change-detection task.

SA has to fit the data with increasing swap error

VP can get away with binding.

Neuron version can do fit the data too, but it’s difficult to fit.

Bayesian inference rule with different level of knowledge.

Mention Donkin’s study, and the failure of SA model

IM is less affected.

References

Last Name, F. M. (Year). Article Title. *Journal Title*, Pages From - To.

Last Name, F. M. (Year). *Book Title.* City Name: Publisher Name.

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Tables

Table 1

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