INFO 5310 Psychological and Social Aspects of Technology

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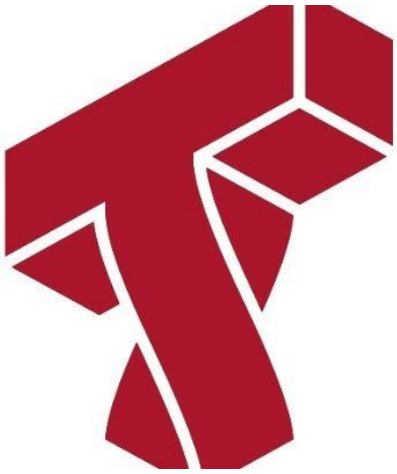

Replication Project:

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Original Paper Summary

In our replication project, we are reproducing the work of Watson & Humphreys in investigating how our brain uses visual marking to prioritize the search of new events (Watson & Hymphreys,1997). The paper investigates a different set of experiments that show how visual selection is prioritized by introducing new objects. The paper's main research question is whether searching for a target over two different sets of distractors would be as efficient as searching over just the latter set, presuming that one of those is presented prior to the other. The authors argue that by performing top-down attentional inhibition, the old static items would be ignored in the search process and only the newly presented set would be searched by the subjects.

To measure the extent of which visual marking occurs the authors conduct several experiments, we are replicating the experiment in section **3b** as outlined in the paper. The baseline/control experiment, the subjects are presented with a set of 8 letters (blue A's), which act as distractors. The subjects are exposed to these letters for a certain period of time that then disappear and are replaced with another set of 8 letter distractors (green H's). The latter set can also contain a target, which in that case was a blue letter *H.* The subjects are asked to identify whether a target was present and the mean response time for a correct answer is recorded. The main experimental treatment applied was making the first set of distractors(blue A's) remain on-screen as the other set (green H's) appear. In both these conditions, the time to which the subjects are exposed to the first set is varied. This time interval is known as the Interstimulus Interval (ISI). The ISI in these experiments is the independent variable, whereas the mean response time to a correct answer (of whether a target was present or not) is the dependent variable. Throughout both the baseline and treatment experiments the ISI was randomly selected to be either 100ms, 400ms, or 800ms.

The goal of the experiment was to determine, if in-fact, given a sufficient ISI time, that subjects would search the two sets of distractors for a target as efficiently (similar response time to a correct answer) as if only the second items were present (baseline condition) by performing top-down attentional inhibition where as the old distractors presented first would be ignored in the search process and only the newly presented set would be searched by the subjects.

Experimental Procedure:

We have conducted several modifications to Watson & Humphreys work to make the experiment more relatable to today's problems, as well as making it more suitable to be conducted online given the current covid-19 health crisis we find ourselves in. Firstly we adapted the experiment to the web, making it more accessible than ever. We optimized the experience to be mobile first given that over half the internet traffic is generated using mobile phones(Statista, 2020). In the original experiment conducted by Watson & Humphreys they used letters as the two sets of distractors, and the target would be different on only one characteristic between both sets of distractors (i.e have the same shape(letter) as the first set and color of the second set). In our adaption we kept the same principle, but instead of using letters we used the three google logos as outlined in Figure 1.

Figure 1: Google logos used (distractor 1, distractor 2 and target respectively)

We believe that these logos would generate similar results to the original experiment, as they all utilize the same colors in the similar fashion and only the shape is slightly different between different logos.

The experiments were conducted over Zoom (video conferencing software) whereas at the beginning of the interview the main objective of the experiment was to be outlined; using the buttons presented on the screen to identify whether the distractor element was present (last item in Figure 1). We then conducted a demo of one experiment using the screen share feature with the participants to ensure they understood the experiment and to answer any outstanding questions. The screen sharing feature allowed the experiment to be conducted in a controlled fashion, hence making this an online lab experiment.

There were two main conditions that we investigated, *Single Feature* condition and *conjunction search* condition. In the conjunction search condition, the experiments start with a blank screen for 500ms followed by a fixation cross for another 1000ms at the center of the screen. The user is asked to focus on the fixation point throughout the experiment when distractors are not present. After that, the first set of distractors appear on the screen as shown in Figure 2. After an ISI (interstimulus interval) of 400ms, 800ms or 1600ms the second set of distractors are presented as shown in Figure 3. In 50% of the cases the second set contained the target and in the other 50% didn't. The participants were asked to identify whether the target is present by pressing the

appropriate button at the bottom of the screen. Our web-application recorded whether the answer was correct as well as the time taken to identify whether a target was present.

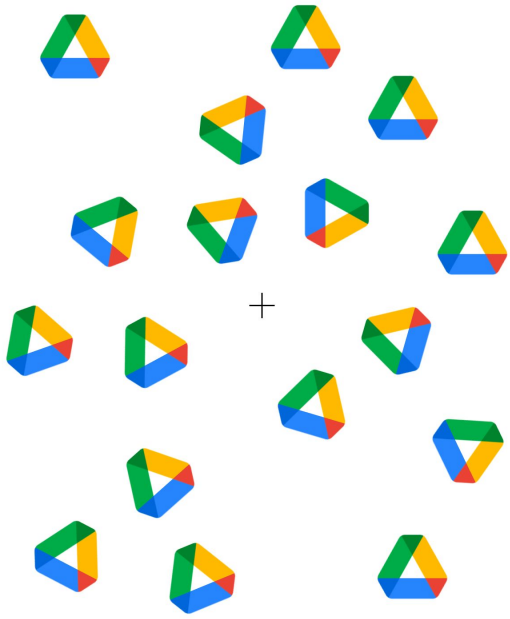

Figure 2:Conjunctional condition: First set of distractors presented

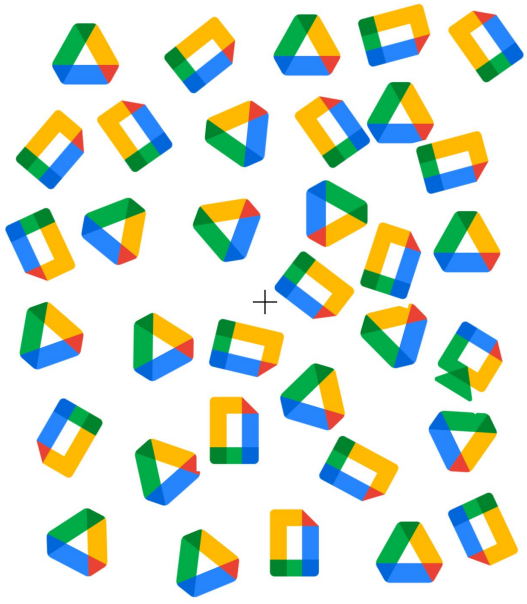

Figure 3:Conjunctional condition: Second set of distractors presented (with target present)

The Single Feature condition followed the same procedure; the only difference was that the first set of distractors disappeared after the ISI lapsed and thus the display size was half that of the conjunction search condition. We used a total of 17 elements in each of the two distractor sets (34 total) and each participant performed a total of 24 trials with varying ISIs (8 for each condition: 200ms, 1000ms or 2000ms) with an equal number of trials where the target present as opposed to not (12 each). Our web-application was created using the React programming language (Github Link) and hosted on Google Cloud Platform. All 24 trials took approximately 15 minutes to conduct for each of our 23 participants.

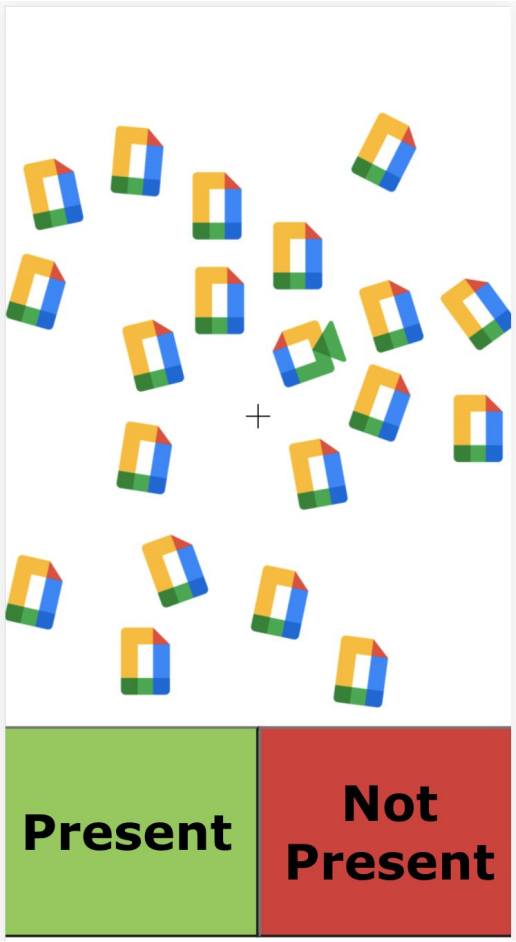

Figure 4: Application screenshot for Single Feature condition (with target present)

In both the single feature condition and conjunction condition our treatment was the variation of the ISI (independent variable) and we measured the mean response time taken to correctly identify whether a target was present or not (dependent variable).

Participants and recruitment technique:

Our experiment was conducted on 23 individuals (13 women, 10 men) all of which have obtained a minimum of a bachelor degree and are aged between 21 and 34 year old. The majority of our participants were Master students at Cornell Tech (14 out of the 23) pursuing a technical degree. The remainder of our participants came from employees in companies in the technology industry as Facebook and Amazon as well as smaller technology startups such as Legacy (YC S19). All of our participants were screened, prior to being selected, for familiarity with the original experiment we are replicating as well. All participants self-reported that they had normal or corrected-to-normal vision and all participants were not compensated for this experiment.

Our experimentation falls in the “within subjects” category where each participant was exposed to multiple treatments (variance in the ISI interval) and each participant was exposed to both conditions (single feature and conjunction feature conditions). We chose to conduct within subject experiments as it allows for variance in results (response time) to be taken into account and would produce more robust results given our small sample size. Also all images shown were introduced randomly on the screen using our code, with an equal number of times where the target was present vs not.

We used a mix of convenience and snowball sampling for this experiment where we initially recruited participants to the study that we had a first or second degree relationship with and then asked them to refer to other participants that they believed would be interested to participate in this study. Our population for this experiment is anyone with good vision and access to a mobile device and internet connection. For our sampling frame, we initially targeted other Cornell Tech students who have not taken INFO 5310 but had some existing relationship with one of our team members. We were able to recruit 9 participants this way. After conducting those experiments and asking the 9 Cornell Tech participants to introduce us to other students who may be interested in our experiment, we were able to recruit 5 other Cornell Tech students. For the remaining 10 participants, we conducted a search on the social media platform Twitter for people tweeting about the new google logos (which we used in our experiment), we reached out to those that we have had interactions with before on Twitter and asked whether they would be interested in participating in the study. Out of the 32 people we reached out to, 17 had agreed and eventually 10 actually showed up and completed the study.

Results

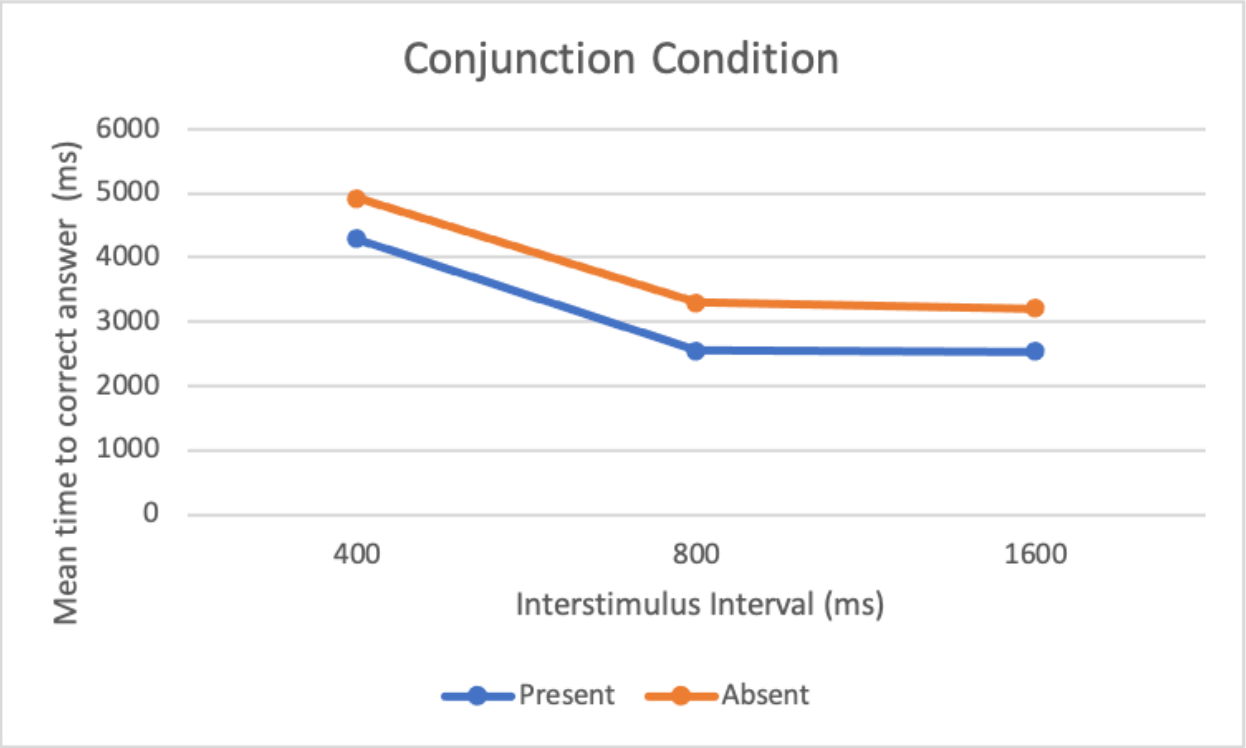

Figure 5: Mean response time for present and absent targets for conjunction condition as a function of duration of the initial set of distractors

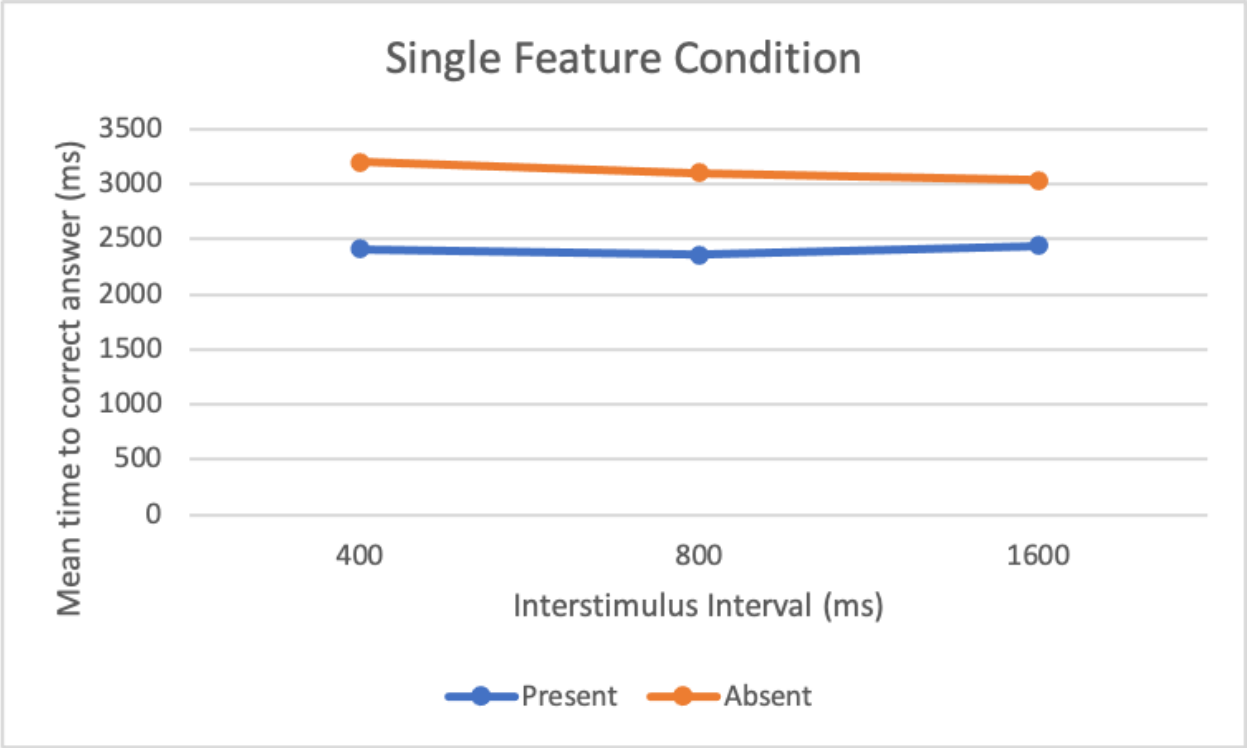

Figure 6: Mean response time for present and absent targets for single feature condition as a function of duration of the initial set of distractors

Figures 5 and 6 show the mean response time to a correct answer for both conditions expected. Two participants outlier results have been omitted from the final tally shown above due to technical errors (slow internet connection). Those participants recorded times that varied by more than 3 standard deviations, however remained consistent with the overall trend of the results observed.

Inspecting the single feature condition alone (where the first set of distractors disappeared prior to the second set being presented), we can see that across the variable ISI the mean response time to a correct answer remained consistent. Overall the average Mean response time across all 21 results recorded has been 2404ms when target was present.

In the conjunction condition, we can see that there is a steep decline between the 400ms trial and the other two trials (800ms and 1600ms) where the average mean response time to a correct answer has dropped by 1735ms from ISI = 400ms to ISI = 800ms when a target was absent and by 1633ms when a target was present. These drops correspond to a decrease of 44% and 33% in response time respectively. For ISI

= 800ms to ISI = 1600ms we see that mean response time remains flat varying be less than 85ms or 3.5% in both the absent and present conditions.

The overall error in our experiment (% where participants identified whether a target was present or not incorrectly) remained fairly low at 5.1%. This equates to 26/504 times that participants were asked to identify whether a target was present on the screen (a total of 21 participants recorded with each conducting 12 runs on each of the two conditions across variable ISIs). The errors experienced skewed towards experiments where the target was present with over 70% of the error occurring when a user selects that a target was absent when in fact it was present.

A summary of the results with mean response time and standard deviations can be seen in Table 1:

Single Feature Condition

Mean Response Time (ms)

ISI	**400ms**	**800ms**	**1600ms**
Present	2412	2359	2441
Absent	3199	3104	3038
Std			
Present	93	102	127
Absent	146	85	110

Conjunction Condition

Mean Response Time (ms)

ISI	**400ms**	**800ms**	**1600ms**
Present	4286	2551	2529
Absent	4924	3291	3205

Std			
Present	293	128	111
Absent	392	198	185

Table 1: Mean Response time and Standard deviations for all experiments

Conclusion

From the results shown above, we can observe that the response time for search taken when a target is absent is always greater than when it is present. This is due to the fact that when conducting search in the case when a target is absent the participant needs to investigate all the elements as opposed to searching until they can find a target. In the conjunction condition we can see that as expected when the time interval (ISI) increases we can see a large decline in the response time that plateaus at 800ms. Upon closer inspection,at an ISI of 800ms we can determine that the time taken to search when a target is absent in the single feature condition and in the conjunction condition is separated by only 155ms as opposed to 1725ms at an ISI of 400ms. This implies that when a participant is performing search in the conjunction condition, the participant is searching fewer items as their exposure to the first set of distractors increases thus proving the phenomenon that people use visual marking when searching items to inhibit or ignore the previously shown sets and only inspect the newly introduced set. As the ISI is increased from 800ms to 1600ms we can see that the response time remains fairly constant between both the single feature condition and conjunction condition, showcasing that it only takes about 800ms for the participant to fully search the first set of distractors when it is presented. The minimal decrease in the response time observed in the single condition experiment as the ISI increases also cements the conclusion that the decrease in the response time in the conjunctional condition is due to the prioritization of the newly introduced set and not any other external condition or phenomenon (if that was the case we would see a similar trend in the single feature condition to that observed in the conjunctional condition).

Further studies:

One aspect that we have not investigated in this study is the impact of internet speed on participants' response time. Since our experiment relies on downloading images hosted on an internet server, low bandwidth can result in variations in the time at which the image is exposed. Overall we tried to mitigate this problem by caching the image in the web browser during the blank screens shown to participants before the start of each experiment. However, in extremely low bandwidth conditions, the time taken to sufficiently cache the image may exceed the 1000ms duration at which a blank screen is exposed. As discussed in this paper, we had already observed this problem with 2 participants who had extremely low bandwidth throughout the experiment and chose to omit those outlier results from our final tally. In further studies, we would conduct this experiment in a more controlled environment where we can ensure adequate internet speed is provided for all its participants to eliminate any noise that may arise from internet issues.

References:

Watson, Derrik G, and Glyn W Humphreys. “Visual Marking: Prioritizing Selection of New Objects by Top-down Attention Inhibition of Old Objects.” *Psychological Review*, vol. 104, no. 1, 1997, pp. 90–122.

Clement, J. “Mobile Percentage of Website Traffic 2020.” *Statista*, 19 Nov. 2020, www.statista.com/statistics/277125/share-of-website-traffic-coming-from-mobile-devices/.

Code - https://github.com/rashmi59/color-game