Replication of Treisman and Gelade

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Abstract

This paper looks at Anne M Treisman and Garry Gelade's paper on "A Feature-Integration Theory of Attention." The article proposes a new hypothesis on the subject of focused attention, specifically the feature-integration theory. Treisman and Gelade tested many models which were consistent with their hypothesis. I replicate this concept, testing for significant differences in percent correct and response time, with regards to set size, task, and target presence. I then relate back to the theories presented by Treisman and Gelade.

Replication of Treisman and Gelade

Literature Review

Treisman et al. (1980) propose a new theory of attention that assumes that features come first in perception. This is called the feature-integration theory of attention. In this theory, features are registered early, automatically, and in parallel across the visual field, while objects are identified separately, and only at a later state, which requires focused attention. (Treisman et al. 1980) Treisman and Gelade claim that attention is ultimately necessary for the correct perception of conjunctions.

Treisman et al. (1980) developed different paradigms to test different predictions from the feature-integration theory:

The visual search paradigm allows people to define a target either by its separate features or by their conjunction. (Treisman et al. 1980) Treisman and Gelade state that if features can be found "in parallel with no attention limits," then the search for targets made up of features like color or shape shouldn't be affected that much by the number of distractors in a specific display.

The texture segregation paradigm states that if texture segregation and figure-ground grouping are preattentive, parallel processes, then they should be determined only by spatial discontinuities between groups of stimuli differing is separable features. (Treisman et al. 1980)

If focused attention to particular objects is prevented, whether it be because time is too short or because attention is directed to other objects, the features of these unattended objects "free float" which allows the possibility of incorrect combinations of features. (Treisman el al. 1980) Treisman and Gelade refer to this as the illusory conjunctions paradigm.

The identity and location paradigm predicts that if attention is prevented, the features of objects that are unattended may be “free floating” spatially, as well as being unrelated to each other. Because of this, people may be able to detect important features without knowing where they are exactly. (Treisman et al. 1980)

The interference from unattended stimuli paradigm states that unattended stimuli should be registered only at the feature level. (Treisman et al. 1980)

These models refer to various types of searches. Serial searches constitutes of searching each target intensely one by one, and seeing whether or not it matches the target. Parallel searches can cover multiple instances as the brain covers more than one stimuli. Parallel searches use pop-out in a simple feature search, and the response time does not depend on how many objects in a simple feature search.

As opposed to single feature searches, conjunctive searches require more attention to combine the required features together. This is where serial searches come into play, as more attention is required to combine the “free-floating” features together. The response time increases with the number of objects in a conjunctive search.

A self-terminating search is when a response is generated as soon as the target is found because the comparisons have stopped. An exhaustive search, on the other hand, is when the entire set of objects in a set has been looked at and compared, and then a response is made.

I will be conducting a replication of the experiments mentioned in Treisman and Gelade’s work. In the replication I will test response time and percent of the answers correct in regards to set size, present vs absent tests, and conjunctive vs disjunctive test. I predict that my findings will be similar to Treisman et al.'s, and that these independent variables mentioned do have a significant effect of percent correct and response time.

Method

In my replication of the experiments performed in Treisman et al, the subjects consisted of students of the COGS-Q370 class from the current semester as well as three previous years, with a total of 70 unique participants. The experiment was run on a computer with an internet browser.

The conjunctive task in the replication was to find the target, a green letter T. The distractors in this test were Red Ts and Green Xs. The target in the disjunctive task was a Red or Green S, or a Blue T or X. The distractors for the disjunctive test were Red Ts, and Green Xs, the same as the conjunctive task.

There were 4 array sizes: 1, 5, 15, and 30 objects, and there were 25 present (Target was present in the trial) and 25 absent (Target not present in trial) trials per condition. The letters were in a circular arrangement to equate for acuity. There were 8 conditions (4 array sizes multiplied by 2 tasks) and these conditions were randomly ordered. There were 50 trials per condition, which comes out to 400 trials.

The radius of circular display was 200 pixels, with 1 pixel equaling .034 centimeters.

The 8 conditions were randomly presented to the participant. The participant would then be asked to find a certain target, and press the corresponding key on the keyboard depending on whether or not they found that target. The response time was recorded.

Results

Looking at the results of the first ANOVA test, there was a significant interaction between target presence and response time, $F(1,69) = 480.13$,$p<8.42e-33$

There was a significant interaction between task and response time, $F(1,69) = 52.46$,$p<4.83e-10$.

There was a significant interaction between set size and response time, $F(3,207) = 465.53$,$p<1.02e-91$.

There was a significant interaction between target presence, task, and response time, $F(1,69) = 46.12$,$p<3.19e-09$.

There was a significant interaction between target presence, set size, and response time, $F(3,207) = 257.50$,$p<1.39e-69$.

There was a significant interaction between task, set size, and response time, $F(3,207) = 62.13$,$p<1.1e-28$.

There was a significant interaction between target presence, task, set size and response time, $F(3,207) = 15.07$,$p<6.54e-09$.

I then ran a regression statistical test measuring response time with independent variables target presence, set size, and task.

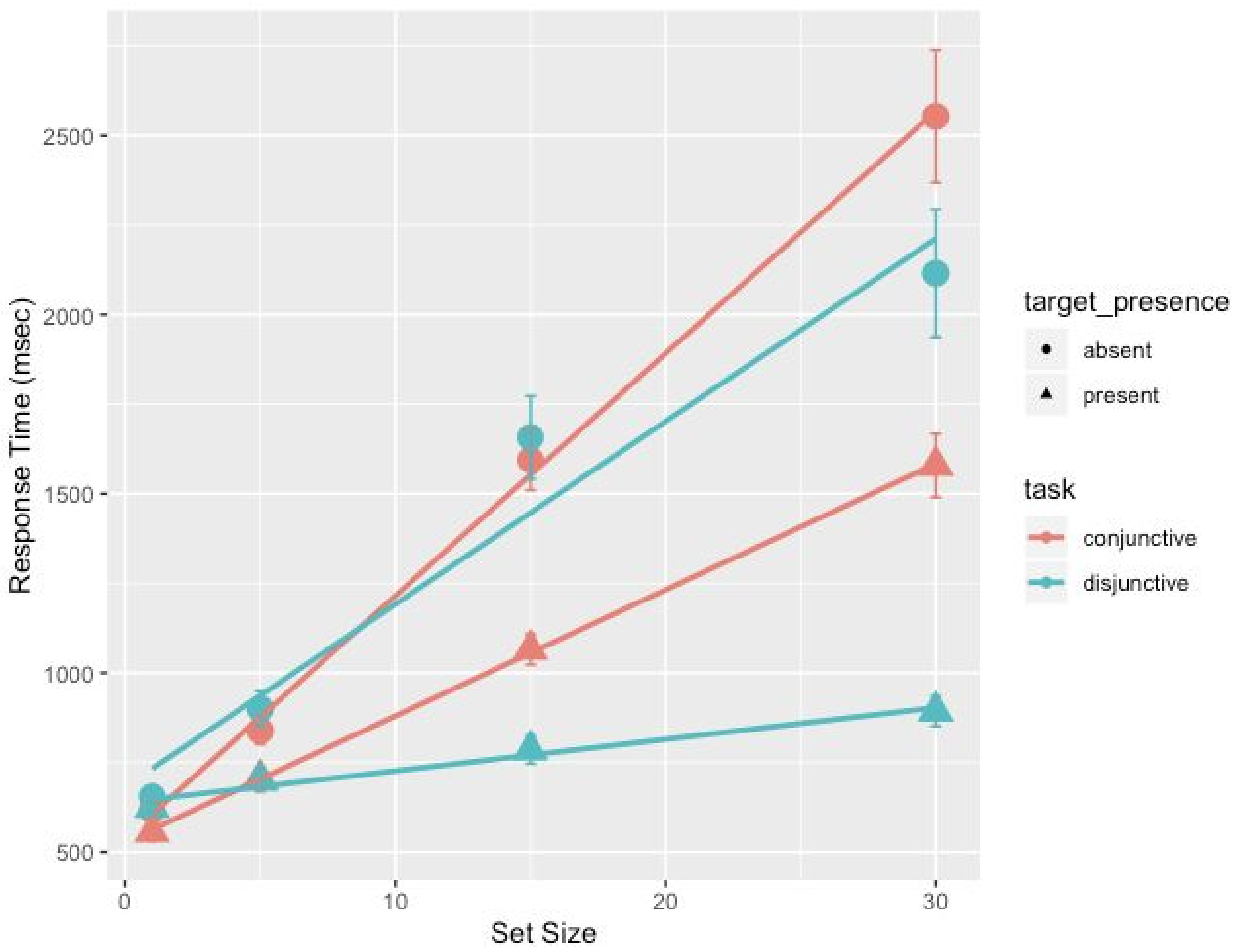

Figure 1. Search times by set size, target presence, and task

The slope of the conjunctive absent test is 67.7 with an intercept of 537.7. The slope of the conjunctive present test was 35.22 and the intercept was 527.21. Treisman et al. predicted that the slope of the conjunctive absent test would be about twice the slope of the conjunctive present test, and that seems to be the case here.

I then ran an ANOVA test testing for a significant interaction with the percentage of responses that were correct.

There was a significant interaction between target presence and percent correct, $F(1,69) = 480.13$, $p<8.52e-33$.

There was a significant interaction between task and percent correct, $F(1,69) = 52.46$, $p<4.83e-10$.

There was a significant interaction between set size and percent correct, $F(3,207) = 465.53$, $p<1.02e-91$.

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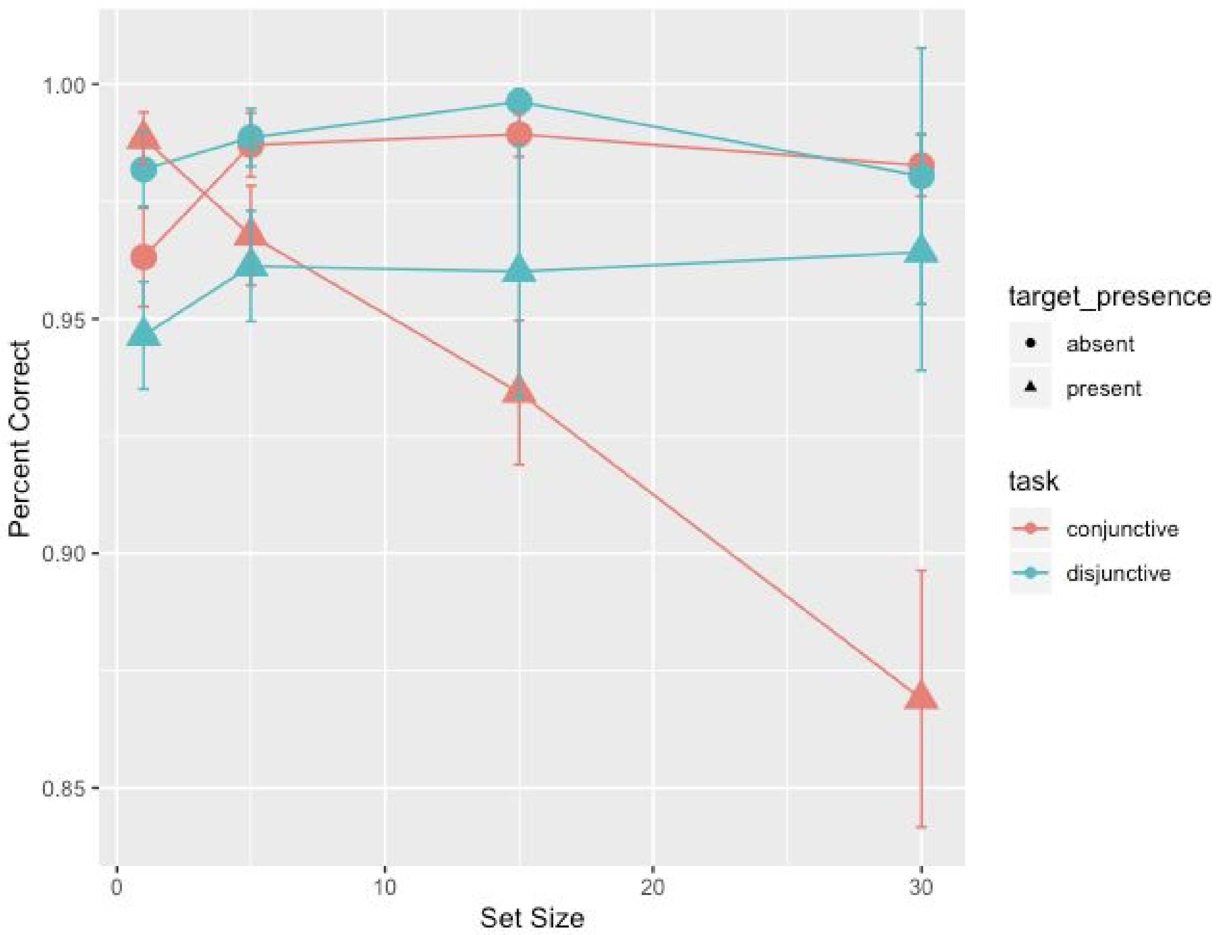

Figure 2. Percent correct when measuring for target presence, task, and set size.

The conjunctive present test had by far the lowest percent correct, which is surprising if we look at our previous graph, which shows that the conjunctive absent test was the one with the longest response time. The other tests don’t really show any significant differences in percent correct, for the most part.

Discussion

By looking at the results of the ANOVA tests, we can see that task, set size, and target presence all had a significant effect on both percent of the answers correct, and response time for all combinations of those variables. Conjunctive tests take more time to get through, as people apply serial searches. If we combine this with a higher stress environment of timing attempts, it would make sense that this would affect percent correct as well, as people make mistakes trying to answer faster.

As Treisman and Gelade mention in their feature integration theory, the brain gathers basic information about features, such as color and shape. This happens without us necessarily being aware of it. This can explain why present tests take a significantly less amount of response time than their absent counterparts. A “feature search” as described by Treisman can be done quickly because the targets can be identified with one feature. This was shown in the replication I did as participants employed a self-terminating search when taking present tests. As soon as they could identify a single feature, such as a Blue T or X, they would end comparisons and record their response.

One discrepancy that I encountered in this replication is that the conjunctive present test did not record the highest response time, but it did record the lowest percent correct, which doesn’t quite line up with the rest of our data. However, the rest of our data did in fact seem to fall in line with the predictions and experiments of Treisman et al. (1980)

References

Treisman, Anne M, and Garry Gelade. “A Feature-Integration Theory of Attention.” *Cognitive Psychology 12*, Academic Press, 1980, pp. 97–136.