Lab 4: Feature Search Integration Theory Replication Experiment

Alexander Mervar

Indiana University

Abstract

This paper looks to replicate the study of Treisman and Gelade (1980), which proposed the idea of Feature Search Integration Theory. To complete this replication, undergraduate students from Indiana University completed a replicated experiment with conjunctive and disjunctive feature search tasks. An example of a conjunctive task is to look for a “green T.” An example of a disjunctive task is to look for a “red or green S” or to look for a “blue T or an X.” There were multiple dependent variables that were manipulated to measure the outcomes of the experiment. Subjects could see a screen with 4 different array sizes, 1, 5, 15, or 30 items. There for 25 randomized present trials and 25 randomized absent trials all conjoined together depending on the array size. Due to these eight conditions, 4 array sizes, present vs. absent, and 50 total trials/condition, each subject completed a total of 400 trials. After running an ANOVA analysis and checking for interactions between variables, this paper can agree with the findings of Treisman and Gelade (1980) as their findings were able to be replicated within this analysis. These findings include

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**Literature Review**

Humans have many attributes for the visual system that can be collected under the idea of pattern recognition. Pattern recognition itself can be split into many different fields and theories. One more antiquated theory is the idea of templates being used for visual pattern recognition. The basic premise of this idea is that the mind has stored templates for what a certain object, character, etc. should look like. Then, after unconsciously measuring which template matches the stimuli in the visual field the most, the subject can recognize that stimuli. This is not without its blunders. With so many different things to possibly present as stimuli, it’s unrealistic to assume that there is a template for any give object. In addition, it does not align with later theories (like Geon Theory), which state that some objects are made up of parts.

Geon Theory, which was originally proposed by Irving Biederman (1987), recognizes this fact. By proposing a consistent set of finite geons that can exist in three-dimensional space, Biederman proposed that you can create objects that can be recognized without the unrealistic assumption that people are constantly managing a vast repository of visual templates to match any stimuli to. It is necessary to point out that this theory is only applicable for structural analysis of a visual stimuli (Biederman, 1987). In scenarios where segmentation of a stimuli is unrealistic, Geon Theory can leave room for another theory. An example of this is how humans apply search and pattern recognition to a two-dimensional stimulus.

Oliver Selfridge was one of the first to propose a theory for patter recognition through an idea that he called “demons” (Selfridge, 1988). The demons would act as indicators for a particular characteristic. (See Appendix A) Using his idea of demons, one is able to break visual stimuli down into different features regardless if they were structural stimuli or not (Selfridge, 1988). Following the matching of the stimuli to these feature demons, the relevant feature demons would communicate to cognitive demons to activate and act as the indicator for a certain stimulus being recognized (Selfridge, 1988). But how do these features relate to search when given multiple distractors?

In Treisman and Gelade (1980), the groundbreaking idea of Feature Search Integration Theory was shared to act as a basis for understanding how humans conduct a search for objects when given alongside several distractor stimuli. Aligning with the findings of Wang, Cavanagh, and Green (1994), features can create a form of pop-out to subjects when presented but, Treisman and Gelade offer and explanation for what features are able to create this phenomenon. Feature Search Integration Theory is also robust enough to touch on the fact that some searches can be conjunctive or disjunctive in manner and can be conducted with very few or very many other stimuli presented alongside a present or absent trial (Treisman & Gelade, 1980).

Following the theory of Feature Search Integration Theory, this paper can name a few key characteristics to search that other theories lack. First, search can be conducted in a parallel or a serial manner (Treisman & Gelade, 1980). If search is conducted in parallel, all stimuli (regardless to the fact if they are distractor stimuli or not) are processed by the subject within the same moment. If search is conducted in a serial fashion, each individual stimuli is processed one at a time to take in the array of given stimuli. Another characteristic of search through a given array of stimuli is whether the search is self-terminating or exhaustive (Treisman & Gelade, 1980). Self-terminating search is when, once the desired stimuli is found, the search is terminated. This kind of search is applicable to present trials. But, when the desired stimuli is absent and the subject much process every distractor to ensure this conclusion, the search does not terminate until every item in the array has been analyzed (Treisman & Gelade, 1980). This is an example of exhaustive search.

The object of this paper is to replicate the findings of Treisman and Gelade in their 1980 publication, which proposed Feature Search Integration Theory. If confirmed, it can be claimed that simple features can be detected through parallel search and conjunctions of different features require more attention, which results in a higher response time from subjects to process the conjunctive stimuli (Treisman & Gelade, 1980). It can also be expected to see an interaction between task and display size, a 2-to-1 slope ratio between conjunctive and present and absent tasks, and an interaction between task, display size, and target type.

**Methods**

To conduct this experiment undergraduate students from Indiana University were subjected to 400 trials each to find a particular stimulus amongst an array of distractor stimuli. There was a total of 149 subjects that participated in this study. Due to human error, some subjects were removed from the possible entries in the dataset, which resulted in 144 unique and acceptable subjects. (An example of a bad subject would be subjects that didn’t complete the 400 trials or completed more than 400 trials due to not logging their identifier when logging into the software.) Subjects were presented a software on a computer that gave randomized present or absent trials in varying array sizes of 1, 5, 15, or 30 stimuli. They were also given conjunctive and disjunctive tasks. There were 25 present trials per condition and 25 absent trials per condition, which were presented in a random order to each participant. Each screen presented to the subject had to possible inputs from the subject, present or absent. After the subject pressed a corresponding key on the computer, the next screen was presented. Each array of stimuli was presented in a circular arrangement to letters to equate for acuity. Each circular display had a radius of 200 pixels (68 cm).

**Results**

Once trials were complete, an ANOVA analysis was conducted on the collected data.

Table

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Seen from the analysis, this paper can reject the null hypothesis unanimously across the board when it comes to any interactions between set\_size, target\_presence, and task. This ANOVA analysis breaks down each dependent variable within the experiment and measures the chances of getting those results if the null hypothesis, which is the hypothesis that these results are not noteworthy, was true. By having a p < 0.05, this paper can ensure that these are significant results, can reject the null hypothesis, and can make claims towards the validity of Treisman and Gelade’s Feature Search Integration Theory.

Next this paper looks to create the graph provided in Treisman and Gelade’s original 1980 paper, which points to the difference between present-conjunctive, present-disjunctive, absent-conjunctive, and absent-disjunctive tasks in regards to response time.

Chart, line chart

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Through this graph, we can see a clear interaction between target presence and task type. Looking at this graph, we align with the fact that disjunctive searches take less time than conjunctive searches due to the necessity for less attention. In addition, we can see that disjunctive present trials point to the reality of the pop-out model that was proposed to explain simple feature search drastically decreasing response time.

This paper also did an ANOVA analysis over several variables.

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Finally, the paper also looked at the values for the percent correct between present-conjunctive, present-disjunctive, absent-conjunctive, and absent-disjunctive trials.

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As illustrated from the graph, as subjects continued through the experiment, their accuracy slightly increased with one exception being present-conjunctive tasks. With present-conjunctive tasks, as more and more distractor stimuli were added to the array, it became clear that subjects had a higher level of difficulty making the correct judgement.

**Discussion**

Following the presentation of the two ANOVA analyses and the provided regression modeling. Our experiment can reject the null hypothesis and claim significance due to p < 0.05. This can be interpreted to fall in support of Treisman and Gelade’s theory of Feature Search Integration Theory. From the above analysis we can conclude, conjunctive response time is greater than disjunctive response times, display size matters more for conjunctive tasks rather than disjunctive tasks, completing a conjunctive absent search requires an exhaustive search, and there is indeed an interaction between task, display size, and target type. All of these are in alignment with Feature Search Integration Theory. This paper has successfully replicated Treisman and Gelade’s findings.

References

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Appendix A

An Illustration of Selfridge’s Pandemonium Model Featuring Demons

Diagram

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