

FIT Experiment 2021

Pre-Registration Report

Study Information

Title

Replication of a Feature Integration Theory Study (1980 Treisman & Gelade)

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Description

This experiment is a replication of Experiment 1 of the 1980 Treisman & Gelade Paper *A Feature-Integration Theory of Attention*. The experiment is based on similar research conducted by Treisman, Sykes, and Gelade (1977). The theory under investigation is called the Feature Integration Theory of Attention. It proposes that prior to objects being recognized by the brain, individual features of objects are registered automatically, fast, and in parallel over the whole visual field (Treisman & Gelade, 1980). Yet, the combination and binding of two or more features to eventually form a coherent, recognizable object needs focused selective sequential attention on item after item and is therefore slower (Wolfe, 2014).

This experiment tests two predictions of feature-integration theory regarding visual search: The first prediction is that a target item can be quickly distinguished from a set of distractors by one feature dimension alone via a phenomenon called the pop-out effect in the case where that feature is not shared by the distractors. For example the distractors are X and T and the Target is an S. Pop-out is part of visual parallel processing which operates quickly and without significant interference from the distractors.

The second prediction states that a target item that is only distinguishable through the combination of two feature dimensions shared with the other distractors requires additional attentional binding through sequential processing of all items. For example the distractors are green X and brown T and the target is a green T. Sequential processing time then linearly increases with respect to the number of distractors present.

The attempt to replicate this work enables us to use modern computational resources to track reaction time, perform a fully randomized task, and analyze the data with the possibility of less human-based biases.

Hypotheses

We assume that in replicating this study we are going to find closely related results compared to the original study. This leads us to form our experimental hypotheses on the basis of the original experiment, with the added inverse Null-Hypotheses we are aiming to reject:

1. When a target is distinguishable by one novel feature dimension, identification is mediated by the phenomenon of feature pop-out leading to no significant increase in reaction time with respect to an increase of the number of distractors (1, 5, 15, 30). The Target Features that are investigated are a brown S, green S, a blue X and a blue T. (Feature Condition)

H_{0F} : Reaction time increases with respect to an increase in display size in the feature condition. Meaning that the GLM-coefficient of display size is non-zero.

2. When a target is distinguishable by the combination of two present feature dimensions, identification is facilitated by sequential processing of objects and their features leading to a linear increase of reaction times with respect to the number of distractors (1, 5, 15, 30). The Target Feature looked at here is a green T. (Conjunction Condition).

H_{0C} : Reaction time does not increase with respect to an increase in display size in the conjunction condition. Meaning that the GLM-coefficient of the interaction term between display size and conjunction condition is zero.

Design Plan

Study type

In order to collect as accurate data as possible, the study will be established as a thoroughly considered experimental setup. The experiment will be conducted as a browser based online keypress task, in which subjects are asked to either press the „L“-key or the „S“-key.

Blinding

Since the experiment will be executed as a within-subject design and the participants will provide data points to every present variable combination, no blinding of participants is necessary. There will be a random assignment that determines with which condition (feature or conjunction) the subjects begin. This assignment will happen without supplying any further information to the subjects.

Material

The stimuli presented to the subjects will be designed taking the description of Treisman and Gelade (1980) as a model, while the stimulus picture will not be drawn by hand but are constructed digitally. For each combination of feature or conjunction condition (2), absence/presence of the target (2) and a number of presented items (items = 1/5/15/30, $n = 4$) there will be 8 stimulus pictures, making for $(2 \times 2 \times 4 \times 8$

=)128 pictures in total. There will be additional pictures in each condition and display size for the practice trials, which won't be considered for the analysis. Target-stimuli will consist of n-1 of the two kinds of distractors Tbrown and Xgreen plus the target. Stimuli without a target have an additional distractor in their place. In the case of an uneven distractor count half of the cards showed one more Tbrown and the other half one more Xgreen.

Study Design

As mentioned before the experiment is planned as a within-subject design in which every participant runs through every possible combination of conditions. The material provides several stimuli of the same variable combination resulting in a repeated-measure design.

The factor „condition“ was originally divided into „conjunctive“ and „feature“ trials and there is a further distinction of disjunctive color trials from disjunctive shape trials in the feature condition.

In the „feature“ condition four different targets are possible: The two in the „shape“ sub-condition occur in the form of a different letter (S) than all other items while having one of the two identical colors to the distractors (green or brown). In the „color“ sub condition a third color (blue) is introduced solely for the target letter which is now identical to the distractors (X or T).

In the „conjunctive“ condition the participant is asked to detect a target (Tgreen) that shares the color (green) as one half of the distractors (Xgreen) as well as the shape (T) of the distractors (Tbrown).

Feature		Conjunction	Distractors
X T Color	S S Shape	T	T X

Table 1: Four different targets for the feature condition (Xblue, Tblue, Sbrown, Sgreen), one target for the conjunction condition (Tgreen) as well as the two distractors (Tbrown, Xgreen)

Each participant is going to complete a total of 384 trials, divided into 6 blocks, each consisting of 64 conjunctive and 64 feature trials each. Preceding the first block, the subjects additionally absolve 16 practice trials in which they are shown an example for every variable combination.

At all stages of the experiment, the subject will see the remaining amount of work in the form of a progress bar. Further, the subjects will be provided with instructions before every part of the experiment. Before each trial, a screen with a fixation cross will be shown on the screen for 1 sec. The subjects further will receive feedback after every trial. For every trial, the reaction time (the time within which the subject detects the target or decides that there is no target visible on the screen indicated through a key-press) is measured.

The experiment will be implemented in _magpie and is going to use several inbuilt functions.

Randomization

The trial order will be randomized with the help of the inbuilt functions of the implementation program. It will mainly create a well-shuffled order of presented stimuli. There will further be a shuffle of starting conditions implemented in the experiment which does not replicate the original shuffle but assigns the condition randomly. In the original experiment, the blocks were presented in an ABBAAB manner which is not going to be replicated here but will instead be replaced by a shuffling algorithm in order to minimize any structure-induced bias.

Sampling Plan

Existing Data

Already existing raw data from the original study (1980, N=6) are not available to us. Therefore, they are not included in the final analysis of this study. As the Preregistration is prior to data collection there is no data available at the time of preregistration. The experiment will be piloted through the team members to receive some preliminary data.

Explanation of Existing Data

The existing data from testing the experiment and testing the preliminary analyses is not included in the final analysis.

Data Collection Procedures

Participants will partake in the online study through the Online Platform Netlify and the data is stored on the _magpie server. The recruitment of participants will be carried out through social media, email distributors, and direct email contact. Participation is voluntary and cannot be compensated with monetary measures or any other equivalent compensation (VP-hours). Every participant is only allowed to take part once. We require certain conditions from the participants. They need to be over the age of 18, fluent or have a good understanding of the English language, a device that can connect to the internet and has a keyboard. It is further required that all participants have no impaired vision (glasses are alright) and are not diagnosed with poor concentration.

Sample size

We are aiming to recruit as many participants as possible with an attempted sample size of 20 participants.

Sample size rationale

As we have to hand in this project by a set deadline we cannot state the exact number of participants to be drafted. Further, we only have a limited participant pool and we have no monetary and other incentives to offer the participant.
(mehr aber resources technisch restricted)

Stopping rule

The data collection will be stopped as soon as we reach N=20 participants.

Variables

The manipulated/independent variables will be the number of distractors in the search grid (1, 5, 15, 30) on a continuous scale, the categorical condition (the specific colour and shape of the target) and the categorical expected (target/no target) factor of the trial. The dependent/measured variable is the continuous reaction time within which the participants press the assigned keys on the board. For the final analysis only the trials containing a trial will be considered, so this one factor will fall away for the model.

Analysis Plan

For the analysis of the collected data, we are going to use the means of a general linear model in R mainly consisting of the lme4 package. Bootstrapped 95% confidence intervals of the reaction time means will be calculated using the bootstrap() function.

Statistical model

We are going to rely on a general linear regression model that aims at proposing a relationship between the manipulated variables and the measured reaction time. It will be accounted for an interaction of the independent variables. The full model in R syntax is going to look like this:

```
model_conditions = glm(log(RT) ~ condition + displaySize +  
displaySize:condition, data = filter(data_conditions, expected ==  
"target" ))
```

Data Transformation

The data will be tidied in order to work out the observed effects. To do so the data points will be interpreted accounting for the different variables and their levels and the interaction of those. The data will be arranged so that the independent variables *expected* (target/no target) and the *conditions* (conjunction/feature) are categorical factor. The independent variable *displaySize* (1, 5, 15, 30) will be a continuous numerical one. The only relevant contrast coding is in the *conditions* factor and will be set as such:

```
contrasts(data$condition)  
      conjunction  
feature      0  
conjunction  1
```

Inference criteria

We will analyze the 0.95 credible intervals of the mean reaction times for all relevant condition-combinations within the general linear model. To test for significance the built in significance test of the general linear model is going to be executed and interpreted accordingly.

Data Exclusion

We will only exclude data in the case where it is clear that it has not been performed by a human e.g. setting the keyboard to one letter and letting the experiment run by itself.

References

Treisman, A., Gelade, G., (1980), A Feature-Integration Theory of Attention, *Cognitive Psychology* 12, 97-136.

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