Simon Task 2023

Final Report

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Introduction to Programming

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Introduction

The Simon effect describes the discrepancy between reaction time or accuracy of a lateral response to a stimulus which occurs on the same side (left or right) and the opposing side as the response. In order to observe this effect, we conducted a Simon-Task. The experimental and statistical analysis code as well as the recorded data can be found on GitHub.

Methods

We recorded 13 healthy adults [age: 21 - 29, 13 female]. Data Acquisition was done as part of the Introduction to Programming course held by Prof. Dr. Ryszard Auksztulewicz. The recordings took place in a bright room with other participants present which were not actively interfering during the task.

Experimental Display

For this particular Simon-Task, participants are shown either the letter 'R' or the letter 'L' on either side (left or right) of the screen. They are asked to press the keyboard key 'q' when shown the letter 'L,' regardless of where it appeared on the screen, and to press the keyboard key 'p' when shown the letter 'R', also irrespective of its position on screen. This task illustrates the Simon effect since the keyboard keys 'q' and 'p' are on the left and right sides. Hence participants are expected to respond more quickly and with higher accuracy when the target stimulus is presented on the *congruent* side of the screen (e.g. when 'L' is presented on the left side, since the key 'q' is on the left) rather than the *incongruent* side (e.g. when 'L' is presented on the right side, since the key 'q' is on the left). Thus, the experimental design is a 2 x 2 factorial design with letter presentation ('L' or 'R') and stimulus/response congruency (congruent or incongruent) as the independent variables, and accuracy and response time (RT) as the dependent variables.

Starting the experiment, participants are shown a welcome screen followed by 5 instructional screens (Figure 1 A). The instructions are kept short and prompt the participant to press any key on the keyboard to continue to the next screen. On the last screen, participants are warned that the experiment would start with the next click and that they should strive to be as fast as possible while still being accurate.

A

Hello, welcome to the experiment! Please press any key on the keyboard to continue.
In the following experiment, you will be shown a fixation cross followed by either the letter L or the letter R. Please press any key on the keyboard to continue.
The letter will be shown either on the left or the right side of the screen. Please press any key on the keyboard to continue.
When you see the letter L, please press the Q key on the keyboard, regardless of its position on the screen. Please press any key on the keyboard to continue.

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When you see the letter R, please press the P key on the keyboard, regardless of its
position on the screen.
Please press any key on the keyboard to continue.
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Please be as fast as possible while trying to be accurate. Get ready! With the next
click the experiment starts.
Please press any key on the keyboard to continue.
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B

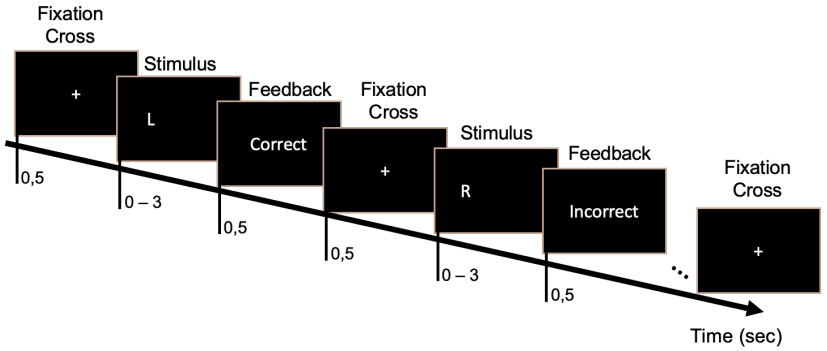

Figure 1 *A* Instructional text shown to participants before the experiem. B Stimulus Timeline.

A for loop was created to display elements for the number of trials (Figure 1 B). Firstly, a fixation cross is displayed for 0.5 s, followed by an 'L' or 'R' presented on one side of the screen or the other. The four experimental conditions are coded as If statements based on a condition table. Feedback is presented to participants as "Correct!" for a correct response, "Incorrect!" for an incorrect response, and "Time out!" if the participants did not respond within 3 seconds. After 135 trials, a goodbye screen is shown with the message, "Thank you for completing the experiment!". The experimental task was programmed with MATLAB (v. 2022b, The MathWorks Inc.) and the Psychophysics toolbox (v.3.0.17, (Brainard, 1997; Kleiner et al., 2007; Pelli, 1997)).

Randomisation

To balance and randomise the conditions, a condition table is created in which the type of stimulus are coded as a number. In the chosen study design, data is meant to be balanced, so that every person is shown an equal amount of congruent and incongruent stimuli as well as an equal amount of "L" or "R" stimuli for the congruent and incongruent conditions. However, the odd number of trials chosen for the experiment run did not allow for the even number of congruent and incongruent trials as well as equal number of "L" and "R" trials. Therefore, each participant is presented with 1 congruent stimuli more than incongruent stimuli and 1 more "L" stimuli compared to the number of "R" stimuli. Therefore, the balancing process results in the creation of a stimuli list for each participant that contains 34 congruent "L" stimuli (code: 10), 34 congruent "R" stimuli (code: 11), 34 incongruent "L" stimuli (code: 20) and 33 incongruent "R" stimuli (code: 21). This oversight should be taken into account when interpreting the results, but should not have a significant effect given the number of trials.

For each participant the order of stimuli is randomised by choosing a random permutation of elements in a balanced stimuli list, to reduce the effect the order of presentation can have on the results.

Stimuli Screens

In the experiment, there are 4 types of stimuli screens. Each one consists of a black screen with a white letter written on one side of the screen. The letters are written in font 150. There are two types of screens corresponding to the congruent stimuli: with letter “L” written on the left side of the screen and with letter “R” written on the right side of the screen. Accordingly, there are two types of the screens for the incongruent stimuli: a letter “L” placed on the right side of the screen and letter “R” placed on the left side of the screen. Additionally, a black screen containing a white cross placed in the middle of the screen is created. This screen with fixation cross is always presented before showing a stimulus screen in each trial.

Recording of Data

The participant ID is used to form unique filenames for each participant session, and using a standard MatLab fprintf() command output the following variables are added to the output file: *RT(response time), accuracy, congruency_1,* and *congruency_2*. Data files have one row per trial of that subject’s session.

Statistical Analysis

The Descriptive statistics are coded using MATLAB. They include the general descriptors of mean, median and standard deviation over all participants. Further, we calculated Confidence Interval (5% and 95%) as well as the mean Error and Accuracy over all participant. Specific to the Simon Effect we calculated the mean “Congruent and Correct” response time, and the mean “Incongruent and Correct” response time for each participant. The inferential statistics are programmed in Python. The single participant values are added to group variables *group_congruents*, and *group_incongruents*. The average Simon Effect is calculated as the mean of ((*group_incongruents*) - (*group_congruents*)), and a paired t-test is performed to find the t-statistic measure of significance of the Simon Effect found. We used a paired t-test because the measured response times for Congruent/Incongruent came from the same group of participants.

Results

We calculated descriptive statistics on the data (Figure 3A) and a paired T-Test for the Simon Effect (Figure 3B). Importantly, the average response time for Congruent and Correct trials during our in-class session was 419ms, while the average response time for Incongruent and Correct trials was 442ms. Hence the Simon Effect observed, that is the difference between these average response times, was around 33ms which represents a 7% response time increase for Incongruent trials over Congruent trials, which is in line with expected results. Thus the Simon Effect between congruent and incongruent trials in this experiment is significant ($t = 0.03$, $df = 12$, $p = 0,02$).

A

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 Despriptive Statistics
Mean RT overall is 0.431
Mean RT of Congurent and correct trials is 0.419
Mean RT of Incongurent and correct trials is 0.442
Mean median RT is 0.406
Mean Standard Deviation is 0.130
Mean Accuracy is 90.7 percent
Mean Error is 9.3 percent
Mean high Conficence Interval is 0.459
Mean low Conficence Interval is 0.413
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B

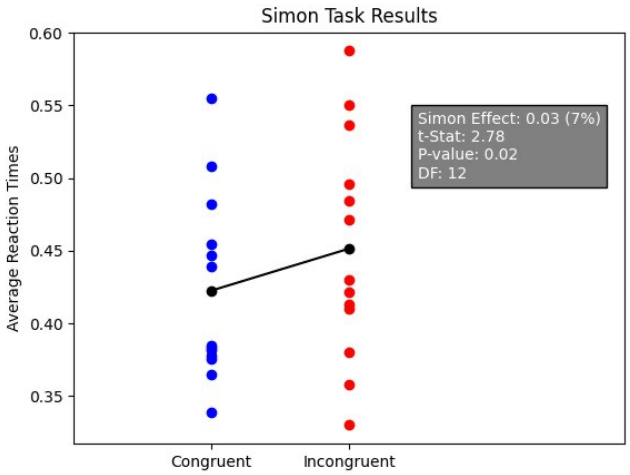

Figure 3 Descriptive and Behavioural Statistics. (A) Overview of all descriptive statistics done on the data set. The general RT description was further split into looking only at the congruent and correct as well as incongruent and correct trials. (B) Paired T-test plot visualizing the significant difference (t = 0.03, df = 12, p = 0,02) in RT in congruent and incongruent trials.

Contributions

Experiment structure, Parameter selection, Statistical Analysis, Quality Testing and Control (Paulsen), Randomization Code and Stimuli Screens (Malinowska), Visual presentation screens and Experimental Loop (Cavender), Data logging, output, and statistical analysis (Wilson).

References

Brainard, D. H. (1997). The Psychophysics Toolbox. *Spatial Vision* , 10(4), 437–442. http://www.psych.ucsb.edu/

Kleiner, M. , Brainard, D. , & Pelli, D. (2007). What's new in Psychtoolbox-3? *Perception*, 36(14 (ECVP Abstract Supplement)).