

## **Preregistration**

and under this link all our experimental files, including picture material can be found

[https://github.com/regg-sketch/compatibility\\_effect](https://github.com/regg-sketch/compatibility_effect)

### **Study information::**

#### **1. Title:**

“Compatibility between Physical Stimulus Size and Left-right Responses: Small is Left and Large is Right” - A replication study

#### **2. Authors:**

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#### **3. Description:**

The theory of magnitude (ATOM, Walsh, 2003, 2015) proposes that cognitive representations of quantity, space and time share a general magnitude code. The research gives evidence, based on neuropsychological and neurophysiological data, that there exists a generalized magnitude system, suggesting overlapping brain structures for the processing of time, space, and magnitude information in the human parietal cortex. (1,2) To investigate this phenomenon, various research has been conducted that examines the relationship between the three.

In a prevailing study, Wühr and Seegelke investigated the correlation between stimulus size and response location.

Results showed significantly faster response times for large stimuli and right-hand responses than for large stimuli and left-hand responses. (There was however no significantly faster response for small stimuli and left-hand responses.) This proposes a compatibility effect between the processing of stimulus size and the spatial location stimuli are found in. (3)

In our experiment we aim to replicate the findings of Wühr and Seegelke by reproducing their experiment, examining whether there is a compatibility effect between large stimuli and right-hand responses, as well as between small stimuli and left-hand responses.

#### **4. Hypotheses:**

- I. There is a stimulus size - response location compatibility effect.

Left-hand responses are significantly faster (have a significant smaller RT) for small stimuli compared to large stimuli. Respectively, right-hand responses are significantly faster (have a significant smaller RT) for large stimuli compared to small stimuli.

**II. Significant stimulus size - response location effects are limited to right-hand responses.**

Only right-hand responses are significantly faster (have a significantly smaller RT) for large stimuli compared to small stimuli in contrast to left-hand responses, which are not significantly faster (have no significantly smaller RT) for small stimuli compared to large stimuli. Or can they also be obtained in left-hand responses (left hand - small stimuli)?

## **Design Plan::**

### **1. Study type**

Experiment

### **2. Blinding**

We will have blinding to that extend that the participants will be naive to the purpose of the study, i.e. they do not know that we are looking for a compatibility effect and what combination is considered as compatible and incompatible.

### **3. Study design**

We have a within subject repeated measure design with the two factors stimulus size and response location. Each have two levels respectively (small vs. large and left vs. right)

(A detailed design plan of the experimental setup can be found in the attached "Design Plan" document.)

### **4. Randomization:**

There will be a randomization between the two experimental phases, so that which block participants get assigned to first is random (either first the left-small and large-right mapping and then the left-large and right-small mapping or vice versa).

## Sampling Plan::

### 1. Existing Data:

Registration prior to creation of data: As of the date of submission of this research plan for preregistration, complete data have not yet been collected, created, or realized.

We conducted a small pilot study, prior to the registration, to test the experimental setup, which will be referred to in more detail in the Analysis part of the preregistration. The pilot data however will not be included in the final analysis report, as it was only a measure to test our implementation for procedural flaws.

### 2. Data collection procedures:

Participants for our study will be right-handed. We will approach this by indicating in the experimental instructions that the participants are only to proceed to the experiment if being right-handed. Also, all participants will be naive to the purpose of the study. As for the number of participants, at least 15-20 participants will be recruited, but they will not be compensated. Participants will be contacted through social media and via email.

### 3. Sample size:

Our target sample size is 15-20 participants, considering the relative short recruitment period. However we generally attempt to recruit as many participants as possible.

## Variables::

### 1. Manipulated Variables:

Independent variables in our experiment are stimulus size and spatial location of the stimulus relative to the participant, which both have two levels. For stimulus size we distinguish between large stimulus (square of 4cmx4cm) and small stimulus (square of 2cmx2cm), and for spatial location we distinguish between left and right.

A third variable (also with two levels) that follows from the two above is the compatibility of stimulus size and spatial location. This compatibility variable is based on our hypothesis, such that in the compatible condition small stimulus and left response / large stimulus and right response are mapped together, while in the

incompatible mapping condition small stimulus and right response, large stimulus and left response are mapped together.

(We expect the reaction times to be significantly smaller in the compatible than in the incompatible mapping condition to confirm our hypothesis.)

## **2. Measured Variables:**

We will have two outcome variables, which on the one hand is the reaction time participants need to press the respective left or right key, and on the other hand if the given response was correct.

We will compare the mean reaction time and mean error percentages of participants for each of the different factor-level combinations. (compatible - right hand response, compatible - left hand response, incompatible - right hand response, incompatible - left hand response).

## **Analysis Plan::**

### **1. Statistical models**

We will use separate two way repeated measure ANOVAs to analyze the 2x2 factorial design. We analyze participants individual mean RTs as well as individual error percentages (dependent variables). The factors are S-R mapping (compatible or incompatible) and Response (left or right). The S-R mapping is varied between, while the Response is varied within experimental blocks. We expect the main effect compatibility (S-R mapping) to be statistically significant

### **2. Inference criteria**

Partial  $\eta^2$  will be used as an effect-size estimate concerning our first hypothesis. Since we have prior expectations of the direction of the mapping effect (the study of Wühr P. and Seegelke gives reason to believe that there is a compatibility effect between large stimuli and right-hand responses, and small stimuli and left-hand responses), we will conduct a one-tailed t-test to examine differences in conditions and test the second hypothesis.

### **3. Data exclusion**

We exclude all data for trials with a RTs of less than 100ms or more than 1500ms. Furthermore, we will exclude participants who have an overall error rate larger than 10%. This is to ensure that the participants are focused on

the task, not randomly pressing buttons. The threshold is so high since the task is relatively simple. Also, the data from the pilot study will not be included in the final analysis report.

## **Pilot study::**

We conducted a pilot study. Data and Analysis script of this can be found attached to the preregistration document. The pilot data however will not be included in the final analysis report

## **Bibliography::**

(1) Walsh, V. (2003). A theory of magnitude: Common cortical metrics of time, space and quantity. *Trends In Cognitive Sciences*, 7, 483–488. DOI: <https://doi.org/10.1016/j.tics.2003.09.002>

(2) Walsh, V. (2015). A theory of magnitude: The parts that sum to number. In: Kadosh, R. C., & Dowker, A. (Eds.), *The Oxford handbook of numerical cognition*, 552–565. New York, NY, US: Oxford University Press.

(3) Wühr, P., and Seegelke, C. 2018 Compatibility between Physical Stimulus Size and Left-right Responses: Small is Left and Large is Right. *Journal of Cognition*, 1(1): 17, pp. 1–11, DOI: <https://doi.org/10.5334/joc.19>