Experimental Design for:

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

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Background::

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. Here we will, in one experiment, look at the relation between physical stimulus size and spatial (mostly horizontal) response location.

In 1990, Dehaene, Dupoux and Mehler firstly showed a compatibility effect between stimulus size and response location, as they found that left-hand responses were faster for smaller numbers and right-hand responses faster for larger numbers. (3)
Ren et al (2011, exp 4) investigated a similar effect for names of small and large objects - they hypothesized that left hand responses were faster for the names of small objects and right hand responses were faster for the names of large objects. However in this experiment, only right-hand responses delivered significant results when addressing large objects compared to small ones, whereas left-hand responses gave no significant findings.(4)

Also, in an experiment conducted by Tzelgov et al. (1992) a size-congruity effect occurred (Tzelgov et al. not only varied the numerical, but also the physical size of the numbers. They found that judging number magnitude was faster when the irrelevant physical size is congruent rather than incongruent with the to-be-judged numerical magnitude). (5)

The experiment we want to conduct is going to be a replication of a study by Wühr and Seegelke (2018). Their previous research also suggests a correlation between stimulus size and response location. While Wühr, and Seegelke could find a significant relation between

large stimuli and right-hand responses, the investigated left-hand responses didn't show significant results for small stimuli. (6)

Hypotheses::

To investigate the correlation between stimulus size and response location that was proposed by previous research, especially by Wühr, P., and Seegelke (C. 2018), we want to address the following research hypotheses:

1. **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.

2. **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 (Materials & Procedure)::

Participants:

Participants for our study will be right-handed, with normal or corrected-to-normal visual acuity. 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.

Materials:

We will provide our own pictures (see above) but we will stick to the sizes presented in the original study using a 2cm*2cm square as the small stimulus and a 4cm*4cm square as the large stimulus. Stimuli will be consistent over the course of the experiment and will be neither varied in color, nor in shape, so that the effect of the spatial location variable maintains the investigated priority.

Procedure:

In contrast to Wühr and Seegelke, we are only able to perform an online experiment using the _magpie key-press method. _Magpie is an architecture which facilitates the development of online experiments. In the key-press method, participants have to press previously assigned keys to convey particular responses in the experiment (e.g. press Q if a small stimulus appears, press P if a large stimulus appears), instead of for example using mouse clicks like in a forced-choice paradigm.

Our experimental setup consists of 6 main parts:

1. *introduction & instructions*
2. *first practice phase*
3. *first experimental phase (mapping one)*
4. *second practice phase*
5. *second experimental phase (mapping two)*
6. *post-experiment questionnaire*

Introduction & Instructions:

After introducing the participants, the experiment will start with the instructions describing the task, including the S-R mapping (stimulus-to-response mapping, meaning which key is assigned to which stimulus), and the sequence of events in the trials.

Participants are instructed to press one of two assigned keys (p and q), respective to the answer they want to give. In one experimental condition they could for instance be told to press p for small stimuli and q for large stimuli, or vice versa. (It is important to mention here that q is always to be pressed with the left hand and p is always to be pressed with the right hand).
As a result of this assignment, two S-R mapping conditions arise, which will be presented to the participants in different blocks.
In the *compatible* mapping condition, the small stimulus will be assigned to the left hand (hence key: q) and the large stimulus to the right hand (hence key: p), whereas in the *incompatible* mapping condition the small stimulus will be assigned to the right hand (key: p) and the large stimulus to the left hand (key: q).

(We chose these mapping conditions in alignment with our hypothesis that right-hand responses are faster for large stimuli and left-hand responses are faster for small stimuli - smaller reaction times in the compatible condition would thus emphasize our hypothesis, while smaller reaction times in the incompatible condition would contradict it.)

Further, to standardize the experiment as much as possible, participants are instructed to use their index finger of the corresponding hand to press the respective key. (This way influence of the response time by use of different fingers can be avoided.)

Practice & experimental phases:

The experiment will consist of four trial blocks. Participants will start with a block of 10 practice-trials, followed by an experimental block with the first S-R mapping (60 trials), followed by 20 practice trials and an experimental block with the second S-R mapping (60 trials). Participants are free to take a break between the first experimental block and the second trial block. The order of the S-R mapping is counterbalanced across participants (compatible-incompatible, incompatible-compatible), and S-R mappings in general are varied within participants.

Each experimental trial starts with the presentation of a fixation cross in the center of the screen for 1000ms. Then the stimulus is displayed in the center of the screen until a key press response occurs, or for 2000ms (to avoid too large response times). As instructed before, participants are expected to press the key corresponding to the

displayed stimulus. (Like the description above states, assignment of keys varies according to S-R mapping.)

A correct response with a RT<2000ms is followed by a blank screen for 1500ms. If the participant responds wrong or doesn't respond in time, an error message informing the participant to either react faster or correctly will be shown for 1500ms in black color.

Post-experimental questionnaire:

The questionnaire will ask participants for their gender (female, male or other), age, educational level, native language and further leave them space for additional comments.

Further General Information::

The general experimental design is within participants, as all participants are presented with both mapping conditions. Independent variables are the *spatial location* of the stimulus (left or right), the *size* of the stimulus (small or large), and the *compatibility* (compatible or incompatible); the investigated/ dependent variable is the *reaction/ response time*.
The design of our experiment is thus a 2x2 factorial design [location x compatibility]; as the compatibility variable is computed as a function of spatial stimulus location and physical stimulus size, the additional size variable becomes obsolete in the analysis.

Bibliography::

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