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Design for a replication study of an "S-R compatibility task"

Background & Motivation

The *A Theory of Magnitude* (ATOM) model proposes that time, space, number and other dimensions are linked through a magnitude system within the parietal lobe (Walsh, 2003). One of the model's predictions is that there are intrinsic reciprocal interactions across magnitude dimensions. If this were the case, manipulating one dimension should correspond with an interfering perception of the other dimension. Indeed, both neurophysiological and behavioral research provide evidence in favor of the ATOM model and its prediction. In behavioral research, the literature contains various studies that observed so-called SNARC effects (**S**patial-**N**umerical **A**ssociation of **R**esponse **C**odes, Dahaene et al, 1993) and size-congruency effects (e.g., Henik et al., 1982). A recent study by Wühr and Seegelke (2018) investigated yet another – rather unexplored – combination of ATOM's implications, namely whether there are compatibility effects between physical stimulus size and spatial response location. Specifically, the study results suggest that small objects are associated with the left side and large objects with the right side. As cumulative evidence in favor of the S-R compatibility effect would extend ATOM's framework, we consider a direct replication attempt as meaningful.

Hypotheses

In accordance to experiment 1 of Wühr and Seegelke (2018), we address the following research hypotheses:

1. Response times are faster in compatible mapping conditions than in incompatible mapping conditions.
2. Error rates are smaller in compatible mapping conditions than in incompatible mapping conditions.
3. Stimulus size-response location compatibility effects yield faster reaction times in right-hand responses than in left-hand responses.
4. Stimulus size-response location compatibility effects yield smaller error rates in right-hand responses than in left-hand responses.

Design

Participants. The premises for taking part in the experiment are either normal or corrected-to-normal visual acuity and good command of English. These premises will be communicated in the invitation and by participation assumed to be fulfilled. Participants are required to report their handedness in the introduction. We will justify the number of necessary participants with a power analysis. The estimate will be included in the preregistration, which will be available on our [GitHub repository](GitHub).

Materials. There are two imperative stimuli across the experiment: One small square (2 x 2 cm) and one large square (4 x 4 cm). In each trial, participants see either one of the squares in the center of the screen and judge whether it is the smaller or the larger one. In both practice and main trials, the same two stimuli are shown in random order. In every trial, the square is shown in front of a

light grey background (hex #f8f8f8). We created both stimuli by ourselves. The materials are available here.
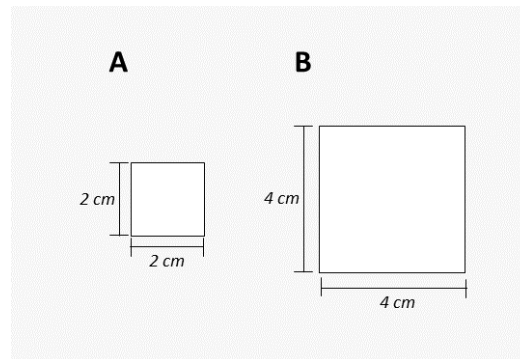

Figure 1: Two stimuli throughout the experiment. In each trial, either the square in panel A or in panel B is shown at the screen center (without height indication).

Procedure. The experiment consists of six parts:
- I. introduction & instructions
- II. practice phase (first S-R mapping)
- III. main test phase (first S-R mapping)
  _____ optional pause
- IV. practice phase (second S-R mapping)
- V. main test phase (second S-R mapping)
- VI. post-experiment questionnaire

After stating the handedness in the introduction, participants are shown written instructions about the task, events in a trial sequence and are presented with the first S-R mapping. Participants will be instructed to use their index finger of their left hand to press the left "tabulator" key and their index finger of their right hand to press the right "backspace" key. The instructions are supplemented with a picture of both stimulus sizes, similar to figure 1.

<u>Trial sequence.</u> Each trial starts with the presentation of a black fixation cross in the center of the screen (_magpie's default font and size). The fixation cross will appear for 1000 ms. Next, a square is presented on the screen (either 2 x 2 cm or 4 x 4 cm). The stimulus is presented on a light grey background (hex #f8f8f8). The participants respond by pressing either the left "tabulator" key or the right "backspace" key, with a maximum period of 2000 ms. If responded correctly within the time limit, the stimulus disappears and a blank screen is shown for 1500 ms. If the participant gave an incorrect answer or did not respond within the time limit, an error message will appear for 1500 ms (black, _magpie's default font and size). Depending on the case, the error message will either read "incorrect answer!" or "too slow!". The trial sequence is the same for both practice and main trials. A visualization of the two possible trial sequences is shown in figure 2. Note that for the large stimulus, the square of size 4 x 4 cm is shown.
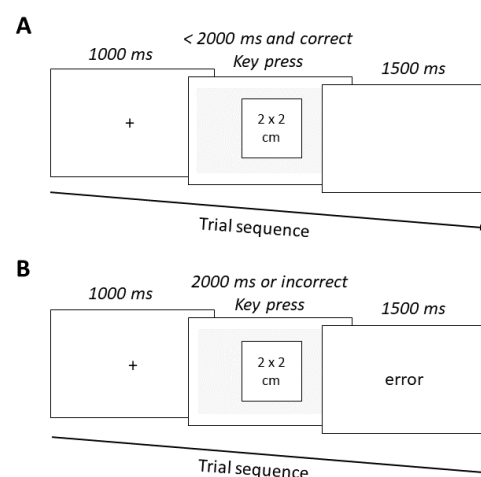

Figure 2: Trial sequence for both practice and main trials. Panel A depicts a correct trial (blank screen), panel B depicts an incorrect or too slow trial (error message). Here, only the small stimulus is shown.

<u>S-R mapping.</u> There are two stimulus-response mapping conditions. In the *compatible* mapping condition, participants should respond to a small stimulus (2 x 2 cm) by pressing the left "tabulator" key and to a large stimulus (4 x 4 cm) by pressing the right "backspace" key. In the *incompatible* mapping condition, participants should respond to a small stimulus by pressing the right "backspace" key and to a large stimulus by pressing the left "tabulator" key. All participants will contribute data to both S-R mapping conditions. The order of mapping conditions (compatible – incompatible or incompatible – compatible) will be counterbalanced across participants. The first S-R mapping condition will be announced in the instructions (I). The participants will be reminded of the changed S-R mapping after the first main test phase (III).

<u>Practice phase.</u> There are two practice phases, one for each S-R mapping. After reading the instructions, participants will enter the first practice phase. In this phase, participants will complete ten trials (2 stimuli x 5 repetitions). After completing the first main test phase, participants will practice the new S-R mapping for 20 trials (2 stimuli x 10 repetitions). Trials in both practice phases are assigned in random order. Data from practice trials will not enter analyses.

<u>Main phase.</u> There are two main test phases, one for each S-R mapping. Each phase consists of 60 trials (2 stimuli x 30 repetitions). Trials are assigned in random order.

<u>Post-experiment questionnaire.</u> The experiment terminates with a post-experiment questionnaire. Here, we ask about age, gender, education, languages and additional comments. All answers are optional.

References

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