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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.[1] 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, Dehaene 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. We will attempt to directly replicate the first experiment of the given study.

Hypotheses

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

I. Response times are faster in the compatible mapping condition than in the incompatible mapping condition.
II. The S-R compatibility effect is more pronounced in right-hand responses.

Besides investigating the existence of a stimulus size-response location compatibility effect as addressed with hypothesis I. above, Wühr and Seegelke (2018) also found that this effect is more pronounced in right-hand responses. Since what counts as 'more pronounced' is ambiguous, and the authors did not elaborate on their interpretation, we decided to split this hypothesis in two. We reason that if the compatibility effect is more pronounced in right-hand responses, right-hand responses should be faster in the compatible mapping condition, and slower in the incompatible mapping condition compared to left-hand responses. Therefore, the discrepancy between the reaction times through manipulation should be larger for right-hand responses than for left-hand responses. We end up with the following hypotheses of interest:

1. Response times are faster in the compatible mapping condition than in the incompatible mapping condition.
2. The compatible S-R mapping yields faster reaction times for right-responses than for left-responses.

[1] Put differently, ATOM proposes that we have an internal representation of "magnitude" across axes (e.g., horizontal or vertical), where magnitude increases or decreases towards the poles of an axis. For instance, if we compare the numbers 1 and 100, we say that 1 is smaller than 100, and 100 is larger than 1. The theory further states that other dimensions (such as space, physical size, etc.), may influence the perceived magnitude of, say, the numerical size.

3. The incompatible S-R mapping yields slower reaction times for right-responses than for left-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. We aim to recruit at least 60 participants.

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. All materials are available here.

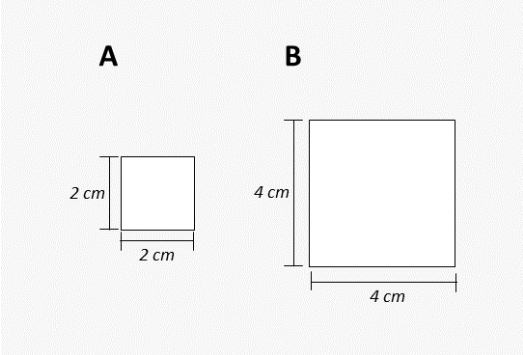

Figure 1: Two stimuli throughout the experiment. In each trial, either square A or square B is shown at the screen center (without height indication).

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 break

IV. practice phase (second S-R mapping)
V. main test phase (second S-R mapping)
VI. post-experiment questionnaire

At first, participants are shown written instructions about the task and are presented with the first S-R mapping. Participants will be instructed to use the index finger of their left hand to press the "q" key and the index finger of their right hand to press the "p" key. We chose those keys because – as opposed to the original study's keys ("tabulator" and "backspace") – they do not differ in size and are easier to implement in _magpie. Furthermore, we think that "q" and "p" suffice to test our hypotheses, as both are still associated with either side. The instructions are supplemented with an image of both stimulus sizes, similar to the one in figure 1.

Trial sequence. 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 at the screen center (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 "q" key or the right "p" 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, an error message "incorrect answer!" will appear for 1500 ms and afterwards it is automatically proceeded to the next trial. If the participant did not respond within the time limit, an error message "too slow!" will appear. In this case, the participant should either click "q" or "p" to proceed to the next trial. Both error messages will be in black and of _magpie's default font and size. 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.

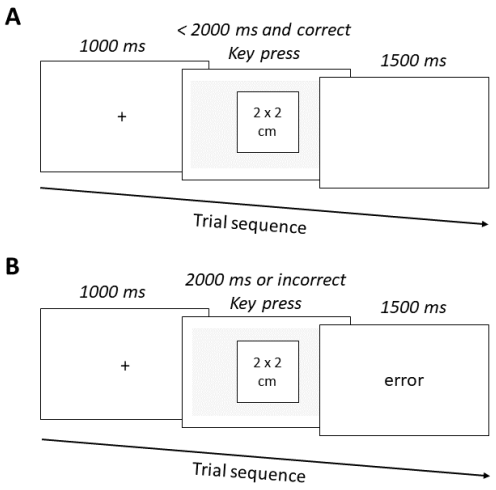

Figure 2: Trial sequence for both practice and main trials. Panel A depicts a correct trial (blank screen), panel B depicts an incorrect or too slow trial (error message). Here, only the small stimulus is shown.

S-R mapping. 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 "q" key and to a large stimulus (4 x 4 cm) by pressing the right "p" key. In the *incompatible* mapping condition, participants should respond to a small stimulus by pressing the right "p" key and to a large stimulus by pressing the left "q" key. All participants will contribute data to both S-R mapping conditions. As opposed to the original study, the order of mapping conditions (compatible – incompatible or incompatible – compatible) will not be counterbalanced across participants. Lacking knowledge of how to implement the counterbalancing in _magpie, we decided to assign the order of mapping conditions in an entirely random, ad hoc fashion at the beginning of the experiment. We think that, according to the Law of Large Numbers, the assignments will still end up approximately even for the number of participants we aim to recruit. The first S-R mapping condition will be announced in the instructions (I). The participants will be informed about the changed S-R mapping after the first main test phase (III).

Practice phase. 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 10 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 the analysis.

Main phase. 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.

Post-experiment questionnaire. The experiment terminates with a post-experiment questionnaire. Here, we ask about age, gender, dominant hand, languages and additional comments. All answers are optional. Participants are encouraged to indicate their handedness.

Links

Link to materials:
https://github.com/ooezenoglu/XPlab-2020-SR-Compatibility/tree/master/experiment/02_main/materials

Link to images shown here:
https://github.com/ooezenoglu/XPlab-2020-SR-Compatibility/tree/master/writing/01-images

Link to Preregistration:
https://github.com/ooezenoglu/XPlab-2020-SR-Compatibility/blob/master/writing/02-preregistration-SR-Compatibility-Task.pdf

References

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Henik, A., & Tzelgov, J. (1982). Is three greater than five: The relation between physical and semantic size in comparison tasks. *Memory & Cognition*, 10, pp. 389–395. DOI: https://doi.org/10.3758/BF03202431

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

Wühr, P., & 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: http://doi.org/10.5334/joc.19