Design for a "Compatibility between Physical Stimulus Size and Left-right Responses" experiment

Background

The processing of cognitive tasks based on somatosensory inputs and motor-sensory outputs is a deeply investigated field of study in the cognitive sciences. Former research proposes "A theory of magnitude" (ATOM, Walsh, 2003, 2015). The theory assumes that the brain uses a generalized magnitude-processing system where the perception of space, time and quantity overlap and interact on an intermediate level of processing antecedent to the response-selection stage. This means that specific properties of the three branches space, time and quantity share a certain representational system. ATOM is therefore regarded as a *shared-representations account*.

For example, it is well accepted that numbers can be represented spatially from left to right (see "SNARC" effect; Dehaene, Dupoux and Mehler, 1990, Dehaene et al. 1993) or that the numerical and physical size of numbers can faster be judged when they are congruent (see "size-congruity effect"; Besner and Coltheart, 1979, Henik and Tzelgov, 1982, Tzelgov, Meyer and Henik, 1992).

In this study we replicate the original paper "Compatibility between Physical Stimulus Size and Left-right Responses: Small is Left and Large is Right" by Wühr and Seegelke (2018). Since in the past the focus of research regarding the ATOM framework lay on interactions of number and size and number and space (see above) but not on the relation between size and space, we here look at how differences in reaction times could support the idea of a horizontal response location representation of stimulus size. We thereby try to answer the question of whether, e.g. a left-hand response is faster for a stimulus of small size than for a stimulus of large size. For that, our task at hand is a classic stimulus – response compatibility task where the participant responds to a single stimulus in each trial, the compatible mapping condition being a left handed response for small stimuli and a right handed response for large stimuli; *vice versa* in the incompatible mapping condition. We then investigate whether the stimulus size – response location compatibility effect only occurs for right-hand or also for left-hand responses, as previous research, for example Ren et al. (2011) and Wühr and Seegelke (2018) already found a larger compatibility effect for right-hand responses than for left-hand responses. The study's results can then be of further assistance for neuroscientific studies, expanding the theory of a shared-representation account, like ATOM.

Hypotheses

To check whether the stimulus size – response compatibility effect goes along the lines of ATOM, we are going to address the following research hypotheses:

1. Reaction times in the compatible mapping condition are faster than in the incompatible mapping condition.
2. The stimulus size – response location compatibility effect is more pronounced for the right-hand than for the left-hand responses; i.e. the difference in reaction times between the compatible and incompatible mapping condition is larger for right-hand responses than the difference for left-hand responses.

Design

Conduction and stimuli. The experiment will be implemented via the _magpie ("Minimal Architecture for the Generation of Portable Interactive Experiments", Illieva, Xiang, Rautenstrauch, Franke) framework and executed solely online. That consequently means that the recording of reaction times might slightly differ because of participants' differing hardware properties. Antecedent to the main study, there will be a pilot study including about 3-5 participants. The main study will then try to at least reach the original paper's number of participants (24 participants), but the goal will be to gather as much data from as many participants as possible. Only right-handed people can take part in the study. We will only use the data from the main study for our analyses, as the pilot study only serves to further improve the experiment's implementation and to figure out the exact analysis methods to use for the main study.

A small black colored "X" sign as a fixation point, a small and a large black colored square will serve as stimuli. While the small one is supposed to be 2x2cm and the big one 4x4cm, in practice we focus on the proportion of these two, as the experiment is conducted as an online experiment, which may cause the squares to differ in actual size on the participant's screen. All stimuli are presented at screen center appearing on a white background and the participants respond by pressing either the left "f" key or the right "j" key. The participant's task is then in each trial to respond with the corresponding key when the stimulus appears. This means that the participant has to press the left "f" key for a small stimulus and the right "j" key for a large stimulus in each trial in the compatible mapping condition and *vice versa* in the incompatible mapping condition.

Procedure. The experiment consists of six parts:

1. introduction & instructions
2. practice phase first mapping condition
3. main phase first mapping condition
4. practice phase second mapping condition
5. main phase second mapping condition
6. post-experiment questionnaire

At the beginning, the participants are shortly informed about the general background of the experiment and also receive written instructions about the task at hand. The instructions emphasize that the participants should strive to optimize speed and accuracy. The instructions are followed by a practice phase (10 trials) as well as the main test phase (60 trials) for the first mapping condition. Afterwards, there is a practice phase (20 trials) and main test phase (60 trials) for the second mapping condition. While in the experimental main trials correct responses are not indicated for the participant, there is a short indication of correctness in the practice trials. We only use the data of the main trials for our data analysis.

Each experimental trial starts with the presentation of the fixation point for 1000ms, followed by the stimulus presented until a key is pressed. Correct responses are followed by a blank screen for 1500ms, for incorrect responses an error screen is shortly presented, followed by a blank screen for 1500ms. The amount of small and large stimuli appearing is balanced within each training and test block. Since the experiment is conducted with a *repeated measures design*, the order of compatibility mapping conditions is *counterbalanced* across participants to control for order effects.

At the end of the experiment, participants are presented with a survey kindly asking them to provide socio-demographic information as well as their handedness. There is also space for further remarks.