# 2. Methods

## 2.1 Participants

## 2.2 Experimental Design and Setup

### 2.2.1 General Procedure

When participants arrived at the lab, they were greeted and informed about the procedure. First, they filled out questionnaires and provided general demographic data. Then, they were prepared for EEG recordings and received a brief oral summary of the task. Afterwards participants could read through a written description of the task on their own. Before the experiment started, participants were presented 16 training trials with feedback on their performance. There was no performance feedback after the training. If they did well and had no further questions, participants proceeded until the end without further interactions with the experimenter. Experimental blocks were separated by breaks that each lasted one minute.

In each of the four blocks 52 trials with four different trialtypes (AX, BX, AY, BY) were presented. One trial included two stimulus types, which consisted of blue and white dot patterns on a black background. The first dot pattern (i.e. the cue) was presented in light blue for 250 ms, followed by a jittered interstimulus interval of 3.5 to 4.5 seconds. The second dot pattern (i.e. the probe) was presented in white for 300 ms. As soon as the probe appeared, subjects had a time window of 800 ms to respond. After 300 ms the probe disappeared. A jittered intertrialinterval of 3.5 to 4.5 seconds followed before the next cue.

### 2.2.2 DPX Paradigm

Participants were instructed to push the right button with their middle finger after a correct cue-probe combination (AX). Incorrect combinations had to be responded to by pushing the left button with their index finger. All dot patterns were constructed starting with a square of nine equidistant dots. These nine positions were used to permute the dots and create different patterns. In the AX combination the cue consisted of three blue dots arranged in a vertical line (A) at the centre of the screen. The corresponding probe had the two upper dots of the vertical line and one on the top right position (X). Any deviation in the cue (B), probe (Y) or in both was considered incorrect.

Across all blocks 208 trials were presented with 136 AX (65.3%) and 24 trials (11.5%) for BX, AY and BY respectively. In order for the paradigm to take effect, AX had to have the highest frequency. Thus, participants developed the dominant response tendency towards AX to push the right button. However, in a small amount of trials (i.e AY) the expectation to see a correct probe after a correct cue was violated with an oddball. Therefore, an AY trial required participants to correct their behavioural planning in the last moment by updating WM in a reactive control style. They had to integrate the surprising information, as the last stimulus and not the cue was the imperative stimulus for their response. By contrast, when subjects saw an incorrect cue, a strong proactivity was triggered. Regardless of the probe, in a trial starting with an incorrect cue there was only one correct response option left. Thus, the incorrect cue, as the imperative stimulus, had to be maintained in WM and subjects engaged in early behavioural control. In trials with an incorrect cue and a correct probe (i.e. BX) subjects had to additionally inhibit the dominant response tendency to push the right button by responding in accordance to the context. The last combination BY was a control condition and most likely did not require cognitive control efforts.

## 2.3 Data acquisition

### 2.3.1 Materials and software

### 2.3.2 EEG data acquisition

### 2.3.3 fMRI data acquisition

### 2.3.4 Measures for simultaneous recordings

## 2.4 Data analyses

### 2.4.1 Behavioural Data

### 2.4.2 fMRI preprocessing

### 2.4.3 EEG preprocessing

### 2.4.3 EEG-informed BOLD prediction and forward head model computation

### 2.4.4 Joint and parallel ICA

### 2.4.5 Partial Least Squares for EEG-fMRI