Prefrontal correlates of translated vs. direct localization responses (#95086)

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1) Have any data been collected for this study already?
No, no data have been collected for this study yet.

2) What's the main question being asked or hypothesis being tested in this study?
If participants localize targets in a sequence, typically no so-called binding effects between response and color emerge. However, if participants have to "translate" their localization response, binding effects can emerge (Schöpper, Lappe, & Frings, in prep.). Binding has previously been shown to have strong prefrontal correlates (e.g., Geissler et al., 2021). Consequently, in the planned study, we will investigate whether the effect of response translation on binding is as well reflected in prefrontal (middle and superior frontal gyrus; MFG and SFG) activity.

3) Describe the key dependent variable(s) specifying how they will be measured.
For behavioral data, dependent measures will be reaction times of probe responses and error rates (percentage of incorrect probe responses after correct prime responses) of probe responses. For neural data, dependent measures will be processing related changes in relative prefrontal concentrations in oxygenated and deoxygenated blood. Hemodynamic changes will be recorded with an eight source, eight detector, portable, time-multiplexed, two wavelengths NIRSport (NIRx Medical Technologies LLC, USA) functional near-infrared spectroscopy (fNIRS) device. Similar to functional magnetic resonance imaging, fNIRS tracks neural activation via the hemodynamic response function. Specifically, fNIRS records activation related changes in cortical oxygenated and deoxygenated blood concentration via their different optical properties. fNIRS optodes will be fixed in a standard 10–10 NIRScaps (NIRx Medical Technologies LLC, USA). For optimal coverage of the MFG AF3, AF4, AF7, AF8, F3, F4, FC1 and FC2 will be chosen as source positions and FP1, FP2, F1, F2, F5, F6, FC3 and FC4 will be chosen as detector positions. This will result in eighteen different channels fourteen of which most likely record the MFG while the remaining four will most likely record the SFG. Signals will be recorded with NIRStar (NIRx Medical Technologies LLC, USA) recording software with a frequency of 7.81 Hz.

4) How many and which conditions will participants be assigned to?
The experiment uses a 2 (Response condition: Translated vs. Direct) x 2 (Response relation: Repetition vs. Change) x 2 (Color relation: Repetition vs. Change) within-subjects repeated-measures design.

For Response Relation and Response condition: Responses are given to one of four target positions on the screen at the top left, bottom left, bottom right, and top right with keys "D", "C", "M", and "K". Keys are pressed with the left middle finger (D), left index finger (C), right index finger (M), and right middle finger (K). The position can repeat or change from prime to probe, demanding the same (response repetition) or a different (response change) response in the probe display. In the translated-response block, participants will press the key diagonally opposite to the spatially congruent key (e.g., "M" for top left target). In the direct-response block, participants will press the spatially congruent key (e.g., "D" for top left target).

For Color relation: The target color (blue or red) can repeat or change from prime to probe.

In turn, there will be eight conditions in this within-design (Response Repetition with Color Repetition, Response Repetition with Color Change, Response Change with Color Repetition, Response Change with Color Change, in the translated and direct block, each).

The experiment will be divided into four parts: 16 Practice trials for the translated block, followed by 288 experimental trials for the translated block; 16 Practice trials for the direct block, followed by 288 experimental trials for the direct block.

To select the best experimental design for the current study, we first conducted a pilot study in which participants gave direct or translated responses to two or four target positions. The design with four target positions revealed the strongest difference between the direct and translated condition; however, this was affected by experimental block order. Thus, we will keep the order for the current study fixed, in that all participants will start with the translated block, followed by the direct block. This order led to the strongest differences between the 4-translated and 4-direct condition in the pilot study.

5) Specify exactly which analyses you will conduct to examine the main question/hypothesis.
For behavioral data: We will conduct a 2 (Response condition: Translated vs. Direct) x 2 (Response relation: Repetition vs. Change) x 2 (Color relation: Repetition vs. Change) within-subjects repeated-measures on probe reaction times. We will conduct the same ANOVA on probe error rates. (Additionally, we will look at the binding effects between response and color separate for the response conditions; however, this will be done after the ANOVA)

For neural data: Preprocessed hemodynamic data will be entered into a two-level general linear model. The first level analysis will be conducted for each

subject separately. At this level, we will estimate the effects processing in each condition has on relative oxygenated and deoxygenated middle and superior frontal blood concentration. Predictors for the general linear model will be derived from triggers set during the experiment by convolving each event with the canonical hemodynamic response function. We will correct for serially autocorrelated errors as well as artifacts induced by systemic physiology and motion with a combined prewhitening and robust regression algorithm. For second level analysis, relevant beta regression coefficients derived from the level one analysis will be entered into weighted mixed effects model estimating a fixed intercept for each experimental condition and a random intercept for each subject to best fit the overall data. Relevant activation comparisons between conditions will be made via t-contrasts. To account for alpha inflation due to multiple comparisons p values will be corrected applying positive false discovery rate. Only contrasts that yield corrected $p < 0.05$ will be regarded as statistically significant.

6) Describe exactly how outliers will be defined and handled, and your precise rule(s) for excluding observations.
Exclusion criteria:
Previous experiments suggest that in some rare cases, some participants do not comply with task instructions and/or have suspiciously high/ unusual error rates. In that case, we will potentially exclude such participants from analysis.
Participants will not be able to register for the experiment if they have participated in the pilot study conducted earlier (this information is logged in our participant system).

Data preparation for reaction times:
Probe reaction times are included if they meet the inclusion criteria for temporal constraints (lower cut-off for anticipatory responses, upper cut-off for unusual high reaction times). Only trials in which the prime and probe response are both correct, will be included.

Data preparation for error rates:
Error rate is the percentage of incorrect probe responses given after a correct prime response. Accordingly, trials will only be included for probe error rate analysis if the prime response was correct.

7) How many observations will be collected or what will determine sample size? No need to justify decision, but be precise about exactly how the number will be determined.
We aim for a sample size of 30 participants. However, we might collect data of more participants, as previous experiments showed that neurophysiological measurements of individual participants can be too noisy for analysis (e.g., bad connection between light emitters and detectors), leading to potential drop-outs, that might be replaced by new participants.

8) Anything else you would like to pre-register? (e.g., secondary analyses, variables collected for exploratory purposes, unusual analyses planned?)
We will collect some demographic data (age, gender, etc.). In our design, all response changes are summarized into one variable; however, response changes can occur due to a position that changes in the vertical, diagonal, or horizontal plane (that all come with a finger change). We will not specify any hypotheses; however, we might exploratively look at how different types of response changes affect the data pattern.