

## Predicting executive functions from eye gaze data in a reasoning test (#45682)

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### Author(s)

Paulo Laurence (Mackenzie Presbyterian University) - p.laurence@hotmail.com

Silvia Bunge (University of California at Berkeley) - sbunge@berkeley.edu

Elizeu Macedo (Mackenzie Presbyterian University) - elizeu.macedo@mackenzie.br

### 1) Have any data been collected for this study already?

It's complicated. We have already collected some data but explain in Question 8 why readers may consider this a valid pre-registration nevertheless.

### 2) What's the main question being asked or hypothesis being tested in this study?

We hypothesize that the rich eye gaze metrics obtained during performance of a reasoning task will reflect several underlying cognitive processes, as measured by tests of planning, working memory, and cognitive flexibility.

#### I. Targeted analyses

We hypothesize that a number of eye gaze metrics will be correlated with all three of the cognitive measures below; however, we seek to test whether specific gaze metrics are correlated with a cognitive test specified below, and - if so - whether they are more closely aligned with this cognitive measure than with the other two.

1. The Tower of London test is a test of planning. We predict that participants who perform better on this test of planning will be more likely to adopt a constructive approach, trying to solve the matrix problem before looking at the answer choices. This should manifest as a higher ratio of time spent on the matrix vs. the answer choices.

2. The Corsi block-tapping test is a test of spatial working memory. We predict that better spatial working memory would correlate with a number of gaze metrics, but that the distinguishing characteristic (as compared with the other cognitive measures) would be fewer gaze transitions between the matrix and the answer choices. On this view, participants with better spatial working memory would be able to keep in mind what the answer should look like when they transition from the matrix to the answer choices -- or, conversely, keep in mind an answer choice and check whether it fits.

3. The Wisconsin Card Sorting task is a test of cognitive flexibility. We predict that participants who make fewer perseverative errors on this task would revisit incorrect answer choices less - that is, that they would make fewer fixations on the incorrect answer choices.

#### II. Exploratory analyses

After testing these specific hypotheses, we seek to conduct exploratory analyses that use a broader range of eyetracking measures, to test which ones are the most diagnostic of different cognitive abilities.

We plan to include the following eye tracking variables:

Number of matrix-matrix transitions.

Number of matrix-answer transitions

Number of answer-answer transitions

Latency to the first fixation on an answer choice

Ratio of time spent on the matrix vs. answer choices

Average number of visits to a given matrix cell

Average number of visits to a given incorrect answer choice

Total number of fixations on matrix cells

Total number of fixations on answer choices

Average fixation duration for a matrix cell

Average fixation duration for an answer choice

### 3) Describe the key dependent variable(s) specifying how they will be measured.

Executive function test scores:

Planning: the Tower of London test movement and time score.

Working memory: the Corsi block-tapping test score;

Cognitive flexibility: Wisconsin Sorting Card Test perseverative error;

Self-reported executive functions: The BRIEF scale

**4) How many and which conditions will participants be assigned to?**

None.

**5) Specify exactly which analyses you will conduct to examine the main question/hypothesis.**

To test each of the targeted hypotheses outlined above regarding relationships between specific gaze metrics and performance on one of the three cognitive tests, we will conduct Pearson or Spearman correlations (based on the data distribution). The correlations coefficient will be compared to the correlation coefficients of the same measure in the other cognitive tasks to see if this measure is more correlated to the predicted cognitive task than the other tasks. We will use the Steiger (1980) correlation comparison test for correlation in the same subjects.

For our exploratory analyses, we will conduct a set of elastic net regressions, predicting performance on each cognitive test as well as the BRIEF task based on the full set of eyetracking metrics specified above.

**6) Describe exactly how outliers will be defined and handled, and your precise rule(s) for excluding observations.**

We will delete participants who are 3 standard deviations from the mean in the Executive Functions tests. Additionally, we will delete participants who have fewer than 50% of eye-tracking data available.

We will include in our analyses only fixations that are in the problem or in the answers and that are over 100 ms.

**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.**

73 participants (the number of participants for whom data are available).

**8) Anything else you would like to pre-register? (e.g., secondary analyses, variables collected for exploratory purposes, unusual analyses planned?)**

The data have already been collected but we don't have access to them yet.

We have several other cognitive measures available: the D2 attention test; the color trails test; the five digits test, Behavioral Assessment of Dysexecutive Syndrome. Depending on the outcome of these analyses, we may expand our scope to these other measures and sociodemographic data.